U.S. DEPARTMENT OF COMMERCE
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PB-296 492

Application of Continuous Watershed Modelling to Feedlot Runoff Management and Control

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Prepared for

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Mar 79

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PB296492

1. REPORT NO. EPA-600/2-79-065	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE APPLICATION OF CONTINUOUS WATERSHED MODELLING TO FEEDLOT RUNOFF MANAGEMENT AND CONTROL		5. REPORT DATE March 1979 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Jerome J. Zovne and James K. Koelliker		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Kansas State University Manhattan, Kansas 66506		10. PROGRAM ELEMENT NO. 1BB770 11. CONTRACT/GRANT NO. R-803797
12. SPONSORING AGENCY NAME AND ADDRESS Robert S. Kerr Environmental Research Lab. - Ada, OK Office of Research and Development U.S. Environmental Protection Agency Ada, Oklahoma 74820		13. TYPE OF REPORT AND PERIOD COVERED Final (6/15/75 - 9/15/77) 14. SPONSORING AGENCY CODE EPA/600/15

15. SUPPLEMENTARY NOTES
Project Officer: Lynn R. Shuyler, Source Management Branch

16. ABSTRACT

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A report on the state-of-the-art of modelling the quality of feedlot runoff is also presented. This report resulted from a meeting of specialists to pool resources on water quality modelling from their respective specialty areas.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Agricultural Wastes	Animal Waste Management	43F
Animal Husbandry	Feedlot Runoff	68D
Waste Disposal	Runoff Retention Designs	
Models	Land Disposal	

18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 168
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE A08-A01

EPA Form 2220-1 (9-73)

☆USGPO: 1979 — 657-060/1638

United States
Environmental Protection
Agency

Robert S. Kerr Environmental Research
Laboratory
Ada OK 74820

EPA-600/2-79-065
March 1979

PB 296492

Research and Development

EPA

Application of Continuous Watershed Modelling to Feedlot Runoff Management and Control

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SPRINGFIELD, VA. 22161

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EPA-600/2-79-065
March 1979

APPLICATION OF CONTINUOUS WATERSHED MODELLING TO FEEDLOT RUNOFF MANAGEMENT AND CONTROL

by

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FOREWORD

The Environmental Protection Agency was established to coordinate administration of the major Federal programs designed to protect the quality of our environment.

An important part of the agency's effort involves the search for information about environmental problems, management techniques and new technologies through which optimum use of the nation's land and water resources can be assured and the threat pollution poses to the welfare of the American people can be minimized.

EPA's Office of Research and Development conducts this search through a nationwide network of research facilities.

As one of these facilities, the Robert S. Kerr Environmental Research Laboratory is responsible for the management of programs to: (a) investigate the nature, transport, fate and management of pollutants in groundwater; (b) develop and demonstrate methods for treating wastewaters with soil and other natural systems; (c) develop and demonstrate pollution control technologies for irrigation return flows, (d) develop and demonstrate pollution control technologies for animal production wastes; (e) develop and demonstrate technologies to prevent, control or abate pollution from the petroleum refining and petrochemical industries, and (f) develop and demonstrate technologies to manage pollution resulting from combinations of industrial wastewaters or industrial/municipal wastewaters.

This report contributes to the knowledge essential if the EPA is to meet the requirements of environmental laws that it establish and enforce pollution control standards which are reasonable, cost effective and provide adequate protection for the American people.

William C. Galegar

William C. Galegar, Director
Robert S. Kerr Environmental
Research Laboratory

PREFACE

The problem of controlling the natural runoff pollution resulting from feedlot operations has received a great deal of attention in the past ten years. As a result of numerous investigations into the volumes and strength of pollutants for the major livestock producing areas of the country, the feedlot industry was identified as a specific category for regulation under the Water Pollution Control Act of 1972. The Act called for the establishment of effluent guidelines and standards of performance for each category.

Due to the fact that the standard of performance adopted was a "no discharge" technology except for rare occurrences of excess precipitation, evaluation or establishment of the standards of performance must consider the climatic conditions at the particular site of a feedlot. "No discharge" suggests only two disposal alternatives, either land application or evaporation of trapped runoff, both of which are dependent upon the same climatic factors. "No discharge" also implies that the feedlot runoff must be managed over the continuum. A continuous watershed model can evaluate at once the climatic situation of a particular site, the unique situation of the open feedlot, the various management alternatives available to control feedlot runoff, and the physical characteristics of the feedlot site. It potentially provides an effective tool to evaluate performance of existing feedlots or aid in the design of new facilities. Modelling will also aid in evaluation of residuals generation for particular feedlots.

The model, Feedlot Runoff Model Kansas State University (FROMKSU), has been developed using data and physical constants applicable to 10 stations in Kansas and to 18 other stations scattered throughout the United States. Extension of its use to conditions markedly different from these stations should be done with great caution. A thorough examination of the physical parameters must be made to insure compatibility to the particular location.

ABSTRACT

A continuous simulation, digital computer, hydrologic model of feedlot runoff generation and disposal has been developed at Kansas State University. The purpose of the model is to establish guidelines and design parameters for feedlot runoff control facilities which will meet the requirements of the Federal Water Pollution Control Act Amendments of 1972. The model continuously monitors the water budget of a feedlot-storage pond-irrigation disposal area control system using historic rainfall and temperature data. It uses only readily available climate, soil, and crop data so that it can be applied to all major livestock producing areas of the United States. The model is expected to be useful in evaluating applications for "permits" to discharge and for 208 planning agencies in "Best Management Practices" for feedlots. A user manual is included with program printout, input data requirements, and an example of a 25-year simulation for Belleville, Kansas.

A report on the state-of-the-art of modelling the quality of feedlot runoff is also presented. This report resulted from a meeting of specialists to pool resources on water quality modelling from their respective specialty areas.

This report was submitted in fulfillment of Contract No. R803797-01-0 by Kansas State University under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period June 15, 1975 to September 14, 1977, and the work was completed September 14, 1977.

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ACKNOWLEDGEMENT

Many people contributed to the formulation of this project and their help was sincerely appreciated. Messrs. Ted Bean, John Anschutz, Howard Neibling and Michael Peterson developed the various essential components of model. Several other graduate research assistants and temporary employees greatly aided us with inputs for the model and computer operations.

The cooperation of Dr. J. Ronald Miner and Dr. Robert Wensink, Oregon State University, is especially recognized. Their collaboration on this project has added an additional dimension to the usability of this model.

SECTION 1

INTRODUCTION

The U.S. Congress enacted the Federal Water Pollution Control Act Amendments (FWPCA) of 1972 (Public Law 92-500) in October of 1972. The Act required the establishment of effluent guidelines for various categories of polluters; one of which was the feedlot industry.

Under the FWPCA, the EPA was charged to define and require the application of best practicable control technology (BPT) currently available to all existing facilities by July 1, 1977. The application of best available technology (BAT) economically achievable was required for all new and existing facilities by July, 1983. The effluent guidelines (8) published on February 14, 1974, in essence state "no discharge" except in the case of an extreme rainfall event. For the application of BPT, this event is the 10-year, 24-hour storm, while for application of BAT it is the 25-year, 24-hour (P25) storm.

The regulations may be interpreted to imply that no discharge is allowed except from a P25 storm or larger for the BAT. Since the only practical means of disposing of accumulated waste is to apply it to the land, the inference is that the feedlot operator will always be able to empty his storage pond prior to any rainfall. He would therefore need pumping capacity sufficient to drain a pond in at least 24 hours and enough land having a sufficient soil moisture deficit to receive all of the excess waste water. While it may be possible to provide enough pumping capacity to drain the pond rapidly, the operator cannot dispose when soil moisture levels are high. As a result, chronic wet weather periods are much more frequently the cause of overflows than the single extreme rainfall event.

In addition, the regulations of March 18, 1976 (35), subject feedlots to a case-by-case designation for evaluation under the national permit program (24,25,28,34). This places a heavy burden on regulators who have to evaluate these facilities. A simple continuous watershed model originally developed by Koelliker (16) for evaluation of long-term performance of runoff control facilities in Kansas and later used in other states has demonstrated usefulness as a design evaluation tool on the state level. Accordingly, a more general model has been developed at Kansas State University, which can appraise various management schemes of land disposal and evaporation facilities at any location throughout the country, as reported by Zovne (42). The model is intended to be an aid to designers as well as enforcement agencies. In addition, it will enable 208 planning agencies to determine "Best Management Practices" for the feedlot category for the whole state or for a particular designated area (27).

SECTION 2

CONCLUSIONS

A continuous soil moisture accounting model has been developed to simulate the operation of a feedlot runoff control system. The model operates using readily available daily temperature and precipitation data. It can evaluate the performance of any particular open, unsurfaced feedlot runoff storage and disposal system at any location in the United States.

The model is intended for use by the various EPA regions in evaluating feedlot control systems in the national "permit" program. The model allows the investigator to determine the required facilities for any level of control which is determined to be the BAT in an area. This evaluation would generally be based upon the percent of wastewater volume controlled over a period of time.

A design technique is also presented which allows a rapid determination of requirements in the absence of the computer program or appropriate data. The accuracy of this approach is limited, and in no case should the tables or charts be extrapolated beyond the range of data used to generate the factors.

In general, it was found that so-called "chronic" weather conditions dominated the storage required for 100 percent control of runoff except in arid to semiarid climates. The pond storage for 100 percent control was generally 1.5 to 3 times the storage required to impound the P25 event in subhumid climates. With ponds of this size an isolated P25 event could not cause an overflow unless it was preceded by "chronic" wet conditions producing antecedent accumulations in the pond.

The percentage of volume controlled has a substantial effect upon pond size. If the performance standard were to be established at 98 percent control of feedlot runoff, half of the 28 stations tested would still need pond storage in excess of that required to impound the P25 event. If 95 percent control were allowed, the required pond size would be approximately 35 percent of the 100 percent control volume.

A procedure for sizing evaporation ponds is also presented. Because evaporation is dependent upon a moisture deficit; that is, a ratio of mean annual precipitation to mean annual evaporation (PREVAP) less than one, this method of disposal is not likely to be utilized in subhumid to humid climates. Also, the nature of the quality of evaporation ponds may preclude any alternate standard of control other than 100 percent.

SECTION 3

RECOMMENDATIONS

Feedlot Runoff Model - Kansas State University (FROMKSU) is a tool which can be applied to evaluate feedlot runoff control systems throughout the country. It is recommended, however, that its application be restricted to investigators who have some hydrologic training and who are conversant in irrigation fundamentals. Key assumptions are disposal rates, soil types, and crop coefficients, all of which require some subjective reasoning and a feel for the situation. In a sense, an investigator should already have a good conceptual model of relationships before using FROMKSU. The computer model then confirms or casts doubt upon the conceptual model and fills in the details. As with any hydrologic model, the model must be adjusted so that long term average rates of interception, evapotranspiration, free evaporation, direct runoff and deep percolation are compatible with what an experienced investigator expects them to be.

Similarly, the simplified design procedure presented herein is not meant to be a substitute for the computer evaluation of a given site. It is meant instead to give general guidelines for various climatic regions or a "ball-park" estimate for a particular site in the absence of computer capability.

The analysis presented herein defines the heretofore undefined term "chronic event." A tool has been developed which can evaluate the performance of any specific feedlot disposal system in the U.S. with regard to both P25 and chronic events. The computer model can be used to design a pond-land disposal system at any level of control desired. If P25 were to continue to be the sole criterion, the approximate average level of control would be 97 percent exclusive of humid areas in the Pacific Northwest and east of the Mississippi River. It would therefore appear advisable to evaluate performance based upon two criteria; the P25 event and the percentage of runoff controlled. The level of runoff percentage controlled depends upon the cost of providing the facilities in a highly competitive industry versus cost of environmental damage resulting from overflows. The results presented herein should provide much needed base data for the more accurate consideration of these competing costs.

SECTION 4

THE MODEL

Because it is a continuous model, the impact of chronic wet weather events can be evaluated in relation to the BPT or BAT requirements. The process as shown in Figure 1 consists of three components. The first component is a model to generate runoff from the feedlot surface. The second is a wastewater (runoff) storage facility model which accounts for pond level fluctuations in response to feedlot runoff inputs, evaporation, and irrigation disposal outputs. The third is a soil-moisture accounting model which enables the monitoring of conditions and the testing of disposal alternatives in an irrigation disposal area. These components are necessary for a complete examination of the interaction between pond volume requirements and irrigation management alternatives.

In synthesizing the model emphasis was placed upon selection of physically meaningful parameters while attempting to minimize inputs required. The goal was a model in which the constants and coefficients in any function could be selected from existing data for any geographic and climatic province in the U.S. The general algorithm of the model is shown in Figure 2. The sequence of operations is an attempt to model the actual stream of events following a rainfall on the feedlot.

POTENTIAL EVAPOTRANSPIRATION

In a recent study (3) fifteen potential evapotranspiration methods were tested on four locations in Wyoming, Colorado, and Nevada. The Penman Combination method was ranked in the top five methods for estimating evapotranspiration. The Penman method produced reasonable results when calibrated for Lake Hefner, Oklahoma (17), Kansas (43), Idaho and California (12). The particular advantage of the equation is that it permits an estimate of natural evaporation from any surface, whether it be water, bare soil, or a vegetated area. The original development is described by Penman (26) and an adaptation of the method applied to irrigation scheduling is described by Jensen (12).

The method is a combination of the energy budget and mass transfer methods taking the form

$$PET = \frac{\Delta}{\Delta + \gamma} (Rn - G) + \frac{\gamma}{\Delta + \gamma} (EA) \tag{1}$$

where PET = the potential evapotranspiration, G = soil heat flux, Rn = daily heat budget at the surface, Δ = slope of the saturation vapor pressure-temperature curve, γ = the psychrometric constant, and EA = a function of wind speed and humidity.

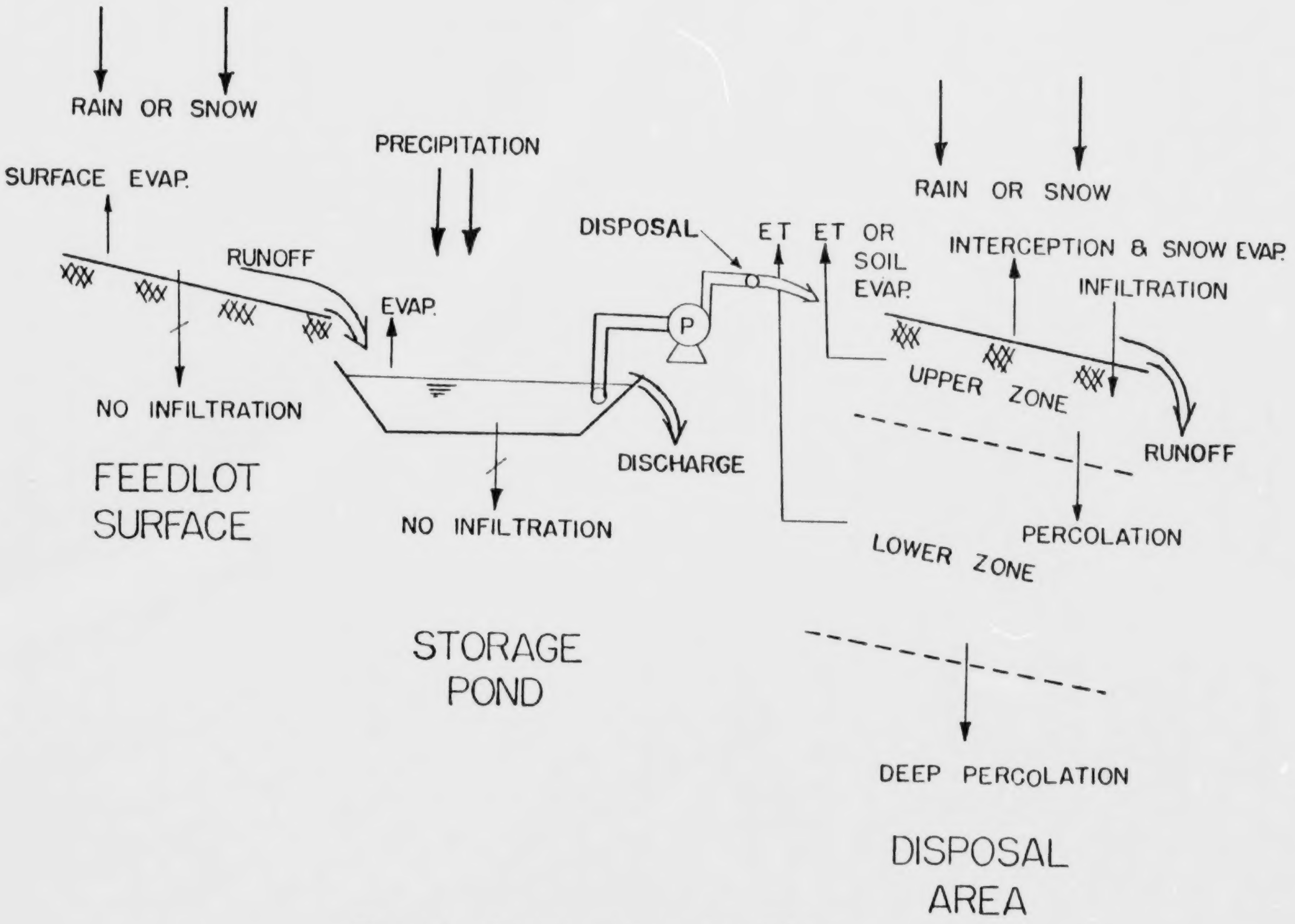
RAIN OR SNOW
SURFACE EVAP.
RUNOFF
NO INFILTRATION
FEEDLOT SURFACE
PRECIPITATION
EVAP.
NO INFILTRATION
STORAGE POND
DISCHARGE
DISPOSAL
P
ET
ET OR SOIL EVAP.
RAIN OR SNOW
INTERCEPTION & SNOW EVAP.
INFILTRATION
UPPER ZONE
RUNOFF
PERCOLATION
LOWER ZONE
DEEP PERCOLATION
DISPOSAL AREA

Figure 1. Process schematic for FROMKSU.

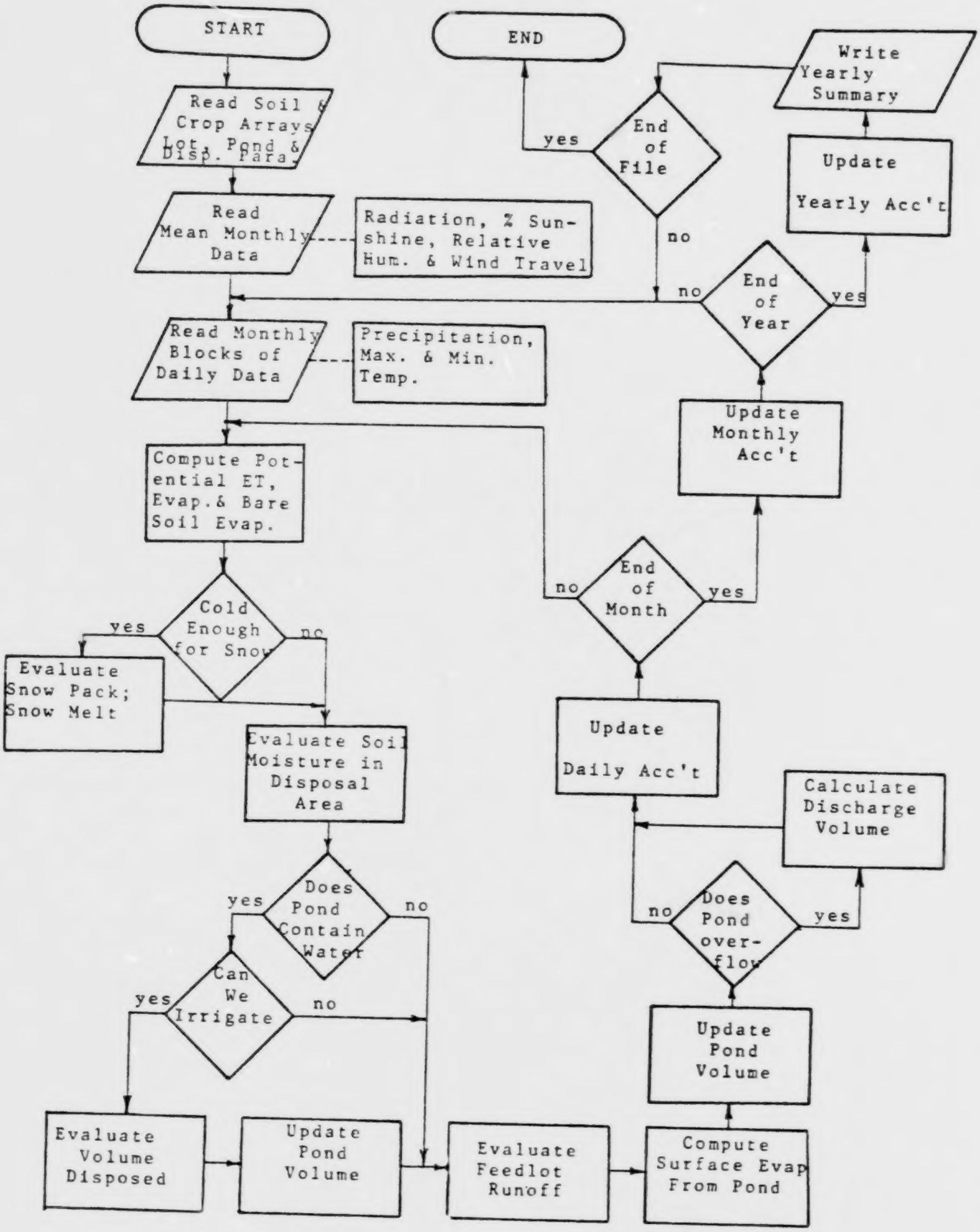
START
END
Write Yearly Summary
Read Soil & Crop Arrays Lot, Pond & Disp. Para.
End of File
yes
no
Update Yearly Acc't
Read Mean Monthly Data
Radiation, % Sunshine, Relative Hum. & Wind Travel
End of Year
no
yes
Read Monthly Blocks of Daily Data
Precipitation, Max. & Min. Temp.
Update Monthly Acc't
Compute Potential ET, Evap. & Bare Soil Evap.
End of Month
no
yes
Cold Enough for Snow
yes
no
Evaluate Snow Pack; Snow Melt
Evaluate Soil Moisture in Disposal Area
Update Daily Acc't
Calculate Discharge Volume
Does Pond Contain Water
yes
no
Does Pond overflow
no
yes
Can We Irrigate
yes
no
Update Pond Volume
Evaluate Volume Disposed
Update Pond Volume
Evaluate Feedlot Runoff
Compute Surface Evap From Pond

Figure 2. The general algorithm for FROMKSU model.

The soil heat flux (G) is a result of rapid changes in air temperature. During the summer months when day-to-day variations in temperature and radiation are not great, soil heat flux is small and can be neglected. Evapotranspiration (ET) is inhibited during the winter months and the effect of this term on ET is small. For these reasons, G is neglected in this model.

The terms $(\frac{\Delta}{\Delta + \gamma})$ and $(\frac{\gamma}{\Delta + \gamma})$ are mean air temperature weighting factors having a sum equal to 1.0. As reported (43), they can be calculated by

$$\frac{\Delta}{\Delta + \gamma} = 0.039\ (Ta)^{0.673} \tag{2}$$

$$(\frac{\gamma}{\Delta + \gamma}) = 1.0 - \frac{\Delta}{\Delta + \gamma} \tag{3}$$

to avoid the inconvenience of data tables and interpolation routines.

The heat budget term is developed in Gray (9, pp. 3.5-3.19) as follows:

$$Rn = (1.0 - r)\ Rsi - Rb \tag{4}$$

where Rsi is the total solar radiation incident to a water surface and

$$Rsi = RA(a + b \times PSUNS) \tag{5a}$$

Then,

$$Rn = (1 - r)\ RA\ (a + b \times PSUNS) - Rb \tag{6}$$

where r = the mean daily shortwave reflectance (albedo), RA = the extraterrestrial solar radiation on a horizontal surface, PSUNS = the percentage of possible sunshine, and a and b are geographical constants. Rb = actual outgoing longwave radiation,

$$Rb = Pe(0.98 - E)(0.1 + 0.9(PSUNS)) \tag{7}$$

and,

$$Pe = \sigma(ABST)^4/58.1 \tag{8}$$

where ABST = the absolute temperature, σ = the Stefan-Boltzmann constant, E = the emissivity. According to Brunt,

$$E = c + d\sqrt{ESA} \tag{9}$$

where ESA = the actual vapor pressure of the air, and

$$ESA = ES \times RHD \tag{10}$$

where RHD = the mean relative humidity; and c and d are geographical constants. According to Linsley (21, p. 35),

$$ES = 33.9[(0.00738Ta + 0.8072)^8 - 0.000019|1.8Ta + 48| + 0.001316] \tag{11}$$

where ES = the saturation pressure of air at the mean daily air temperature, and Ta = the mean daily air temperature.

The aerodynamic term in Eq. 1 is derived as follows:

$$EA = f(u)(ES - ESA) \tag{12}$$

and

$$f(u) = 0.26\ (e + 0.01\ WVD) \tag{13}$$

where f(u) is a function of wind speed and

$$WVD = W(\log 6.6/\log Z) \tag{14}$$

where WVD is the mean wind velocity at 2 meters above the ground, W = the measured wind velocity, and Z = the height, feet, above the ground at which the wind is measured.

The complete, calibrated Penman Combination equation for Belleville, Kansas, is

$$\begin{aligned} PET = {} & 0.039Ta^{0.673}[(1-r)RA(a + b \times PSUNS) - 1.974 \times 10^{-9} (ABST)^{4}(1.0 - c \\ & - d\sqrt{ES \times RHD})(0.1 + 0.9PSUNS)] + (1 - 0.39Ta^{0.673}) \\ & \times 0.26(e + 0.01WVD)(ES - ES \times RHD) \end{aligned} \tag{15}$$

where $a = 0.22$, $b = 0.54$, $c = 0.62$, $d = 0.039$ and $e = 0.5$.

An input value of r = 0.05 results in a potential equivalent to evaporation from a free water surface. The reflectance coefficients for green crops vary from 0.20 to 0.25 (9, p. 3.10). For this model, r = 0.23 is used to calculate PET from the cropped disposal area while r = 0.20 is used to calculate the potential evaporation rate from bare soil. Reflectance coefficients for snow vary from 0.90 for a clean dry surface to 0.40 for a melting, aged snow. A constant value of 0.70 is therefore used in the program for snow.

The remaining inputs to the Penman equation are solar radiation (RA), relative humidity (RHD), wind travel (WVD), percent sunshine (PSUNS) and mean daily temperature (Ta). Although the Penman equation was determined to be the best available method for use in this model, it has the disadvantage of requiring these daily inputs which are not readily available at all locations. In order to reduce model input requirements, Anschutz (personal communication) conducted a study to determine the effects of using mean monthly values of mean daily humidity, wind travel, solar radiation and percent sunshine. These means are readily available from all first order weather stations in the U.S. Using a differential t-test daily PET's calculated with daily inputs tested on a monthly basis were statistically different at the 95 percent confidence level from daily PET's based on monthly averages for five out of twelve months over a 10-year period. When the PET's were blocked and tested in five-day intervals, there were only two out of twelve months in which the two methods were statistically different at the 95 percent level. When the mean monthly values were substituted for daily inputs to the Kansas Watershed Model (43), no significant differences were noted in daily streamflows. Although these tests are indicative rather than conclusive, they are sufficient evidence for using monthly averages in this model. The increase in mobility and decrease in input data more than compensate for a slight decrease in daily accuracy.

The monthly values of RA are dependent upon the latitude of the location and can be interpolated directly from Table 1. The values of a and b adjust RA for diffuse scattering, absorption, and atmospheric reflection losses of solar radiation. Constant values of a = 0.22 and b = 0.54 (9;p.3.9) are used for all locations. Although these coefficients appear to be somewhat dependent upon location and time of year, data is extremely limited.

TABLE 1. MID-MONTHLY INTENSITY OF SOLAR RADIATION ON A HORIZONTAL SURFACE IN mm OF WATER EVAPORATED PER DAY (AFTER CRIDDLE)

	Northern Hemisphere										Southern Hemisphere								
	90°	80°	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
Jan.	..	..	..	1.3	3.6	6.0	8.5	10.8	12.8	14.5	15.8	16.8	17.3	17.3	17.1	16.6	16.5	17.3	17.6
Feb.	..	..	1.1	3.5	5.9	8.3	10.5	12.3	13.9	15.0	15.7	16.0	15.8	15.2	14.1	12.7	11.2	10.5	10.7
Mar.	..	1.8	4.3	6.8	9.1	11.0	12.7	13.9	14.8	15.2	15.1	14.6	13.6	12.2	10.5	8.4	6.1	3.6	1.9
Apr.	7.9	7.8	9.1	11.1	12.7	13.9	14.8	15.2	15.2	14.7	13.8	12.5	10.8	8.8	6.6	4.3	1.9	..	..
May	14.9	14.6	13.6	14.6	15.4	15.9	16.0	15.7	15.0	13.9	12.4	10.7	8.7	6.4	4.1	1.9	0.1	..	..
June	18.1	17.8	17.0	16.5	16.7	16.7	16.5	15.8	14.8	13.4	11.6	9.6	7.4	5.1	2.8	0.8	..	..	..
July	16.8	16.5	15.8	15.7	16.1	16.3	16.2	15.7	14.8	13.5	11.9	10.0	7.8	5.6	3.3	1.2	..	..	..
Aug.	11.2	10.6	11.4	12.7	13.9	14.8	15.3	15.3	15.0	14.2	13.0	11.5	9.6	7.5	5.2	2.9	0.8	..	..
Sept.	2.6	4.0	6.8	8.5	10.5	12.2	13.5	14.4	14.9	14.9	14.4	13.5	12.1	10.5	8.5	6.2	3.8	1.3	..
Oct.	..	0.2	2.4	4.7	7.1	9.3	11.3	12.9	14.1	15.0	15.3	15.3	14.8	13.8	12.5	10.7	8.8	7.1	7.0
Nov.	..	..	0.1	1.9	4.3	6.7	9.1	11.2	13.1	14.6	15.7	16.4	16.7	16.5	16.0	15.2	14.5	15.0	15.3
Dec.	..	..	..	0.9	3.0	5.5	7.9	10.3	12.4	14.3	15.8	16.9	17.6	17.8	17.8	17.5	18.1	18.9	19.3

*Computed from "Manual of Meteorology" by Napier Shaw, Vol. II, Comparative Meteorology, 2nd Edition, Cambridge University Press, 1936, pp. 4 and 5.

Note: Values from the table by Shaw multiplied by 0.86 and divided by 50 give the radiation in mm of water per day.

Mean monthly values of PSUNS, RHD and WVD are taken from Climates of the States (4). For stations other than those listed, values are interpolated from nearby stations. RHD is the early morning value at 4:00, 5:00, or 6:00 a.m., depending upon data available for a particular location. The height above ground at which wind velocity is measured varies from station-to-station and most have changed elevation at least once in the period of record. Therefore, Z = 30 feet* is assumed for all stations. It represents a reasonably average condition.

The coefficient e varies from 0.5 to 1.0. For short green grass Penman (26) reported a value of 1.0. In the Lake Hefner (38) studies a value of 0.5 was reported for a water surface. Wright (41) used a value of 0.75 for a well-watered alfalfa field in southern Idaho. Other discussions are in (3) and (7). In the program e = 0.75 when calculating potential ET and 0.5 when calculating lake evaporation.

The only daily climatic information that is required by the program is precipitation and maximum and minimum air temperatures. Magnetic tapes with this information are available from the National Climate Center, Asheville, N.C. Temperatures are used in equations 2, 8, 11 and 15. In Eq. 11, ES is computed separately for the maximum and minimum temperature. The two values are averaged to obtain the average saturation vapor pressure. The average of the maximum and minimum temperature is used in equations 2, 8, and 5.

The values of c and d in Eq. 15 are quite variable with location and climate. Obtaining good values for a particular location can be very time consuming. A procedure was developed whereby these values could be estimated using Eq. 15, a long record of temperature for a particular station, and the moisture deficit (MD). Moisture deficit is defined as the long-term average annual lake evaporation minus the long-term average annual precipitation. In order to select c and d values, Figure 3 was developed from an analysis of 21 stations scattered throughout the U.S. The data for these stations is given in Table 2.

In Table 2, the computer calculated values of evaporation and moisture deficit for the c and d values and the period of record are listed. The estimated values of annual or seasonal May through October or April through September evaporation from evaporation charts or (5) are also listed. These were used for calibration. The c and d values were plotted against the actual moisture deficit calculated by the program for the period of record in Figure 3.

The moisture deficit for a location can be computed using charts or figures provided by the U.S. Weather Bureau. An excellent discussion of the use of various evaporation maps is given in (40;pp.80-88). For most of the stations in Table 2, pan-evaporation was determined from nearby Class A Pan stations (5). Annual precipitation is also best determined from (5), although maps are readily available elsewhere.

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*A conversion chart for SI units is included in Appendix E.

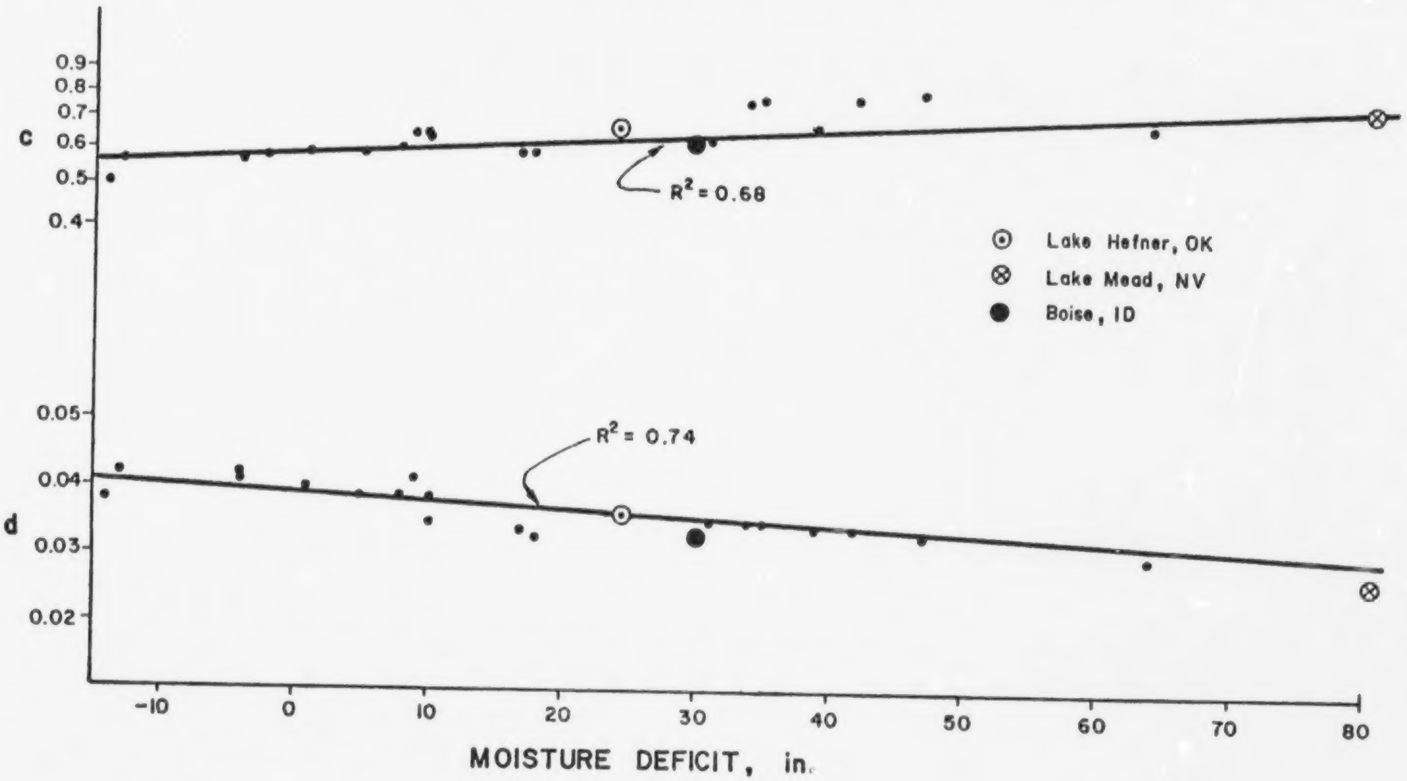

Figure 3. Graphical determination of brunt coefficients (c and d)

TABLE 2. LIST OF c AND d COEFFICIENTS USED IN PENMAN COMBINATION EQUATION

Location	Period	Lake evap.* in.	Moisture deficit† in.	c†	d†	Lake evap.‡
Phoenix, AZ	49-75	70.7**	64	0.69	0.030	70.8**
Sacramento, CA	53-72	56.0**	39	0.69	0.034	56.8**
Dublin, GA	49-73	25.1	-14	0.50	0.038	24.5
Urbana, IL	04-73	29.3	- 2	0.58	0.040	29.0
W. Lafayette, IN	04-73	27.7	- 4	0.56	0.041	26.8
Belleville, KS	49-73	33.2	8	0.62	0.039	32.5
Colby, KS	50-74	44.4	35	0.79	0.035	44.5
Ellsworth, KS	46-70	35.0	18	0.60	0.033	34.5
Garden City, KS	50-74	47.4	42	0.80	0.034	47.3
Hays, KS	48-73	46.3	34	0.78	0.035	47.7
Horton, KS	46-70	29.9	1	0.60	0.040	28.9
Independence, KS	48-72	31.4	5	0.59	0.039	30.9
Topeka, KS	49-73	34.4	9	0.66	0.041	34.3
Crookston, MN	04-73	24.2	5	0.60	0.038	23.6
Minneapolis, MN	04-73	30.3	10	0.67	0.039	30.4
Wooster, OH	04-73	26.0	- 4	0.57	0.042	25.6
Corvallis, OR	31-65	21.2	-13	0.57	0.042	21.3
Pendleton, OR	30-69	33.8	31	0.64	0.035	33.6
Centerville, SD	04-73	30.8	10	0.65	0.035	32.3
Beeville, TX	51-75	47.2**	17	0.60	0.034	46.7**
Hereford, TX	49-73	40.1	47	0.83	0.033	40.5

*Average May-Oct. or April-Sept. value as calculated by Penman Combination Equation using c and d values listed.

†Value used to develop Fig. 3

‡Average May-Oct. or April-Sept. value as determined from Weather Bureau Charts or Climatological Data (5).

**Annual values.

The values of c and d can then be estimated from Figure 3, based upon an estimate of moisture deficit for the location. In the computer program developed for this project, Eq. 15 is solved with $e = 0.5$ and $r = 0.05$ for lake evaporation. The average values of May-October or April-September evaporation and the total annual lake evaporation are printed so that c and d can be adjusted for actual conditions experienced during the simulation period. The c and d values are then adjusted in repetitive runs as needed. An increase in c of 0.01 results in a 1.0 ± 0.25 in. increase in lake evaporation while an increase in d of 0.001 results in an increase of 0.4 ± 0.1 in.

WATER MOVEMENT WITHIN THE DISPOSAL AREA

The disposal area can be conceived as a soil-water reservoir which is recharged by precipitation and irrigation waters and depleted by evapotranspiration. Most annual row crops and grasses develop their root zone in the upper 4 ft. of soil. Since soil water is extracted through the plant roots, most transpiration occurs from this level. Root extraction pattern studies by Russell (30) and a consumptive use study by Manges (personal communication) conducted in England and Kansas have shown that approximately 70 percent is extracted from the upper 1 ft. of soil, with nearly all of the remaining 30 percent being taken from the next 3 ft. On this basis, the disposal area soil-moisture model evaluates soil-water interactions above the 4 ft. level with two layers which are referred to as upper and lower zones. Transpiration is proportioned in the two zones according to root densities. Water which moves vertically downward through both zones is accounted as percolation out of the root zone.

Water is also transferred from the soil to the atmosphere by direct soil evaporation. When soil lies fallow or annual row crops are in the early growth stage providing little vegetative cover, the evapotranspiration is mostly soil evaporation. As plant leaf surface areas increase through the growth stage, direct soil evaporation decreases and plant transpiration increases.

Soil Evaporation

Evaporation from soil generally occurs in two stages (14). First stage evaporation occurs when the soil is sufficiently wet to readily transport water to the surface. This is the constant rate stage in which evaporation proceeds at the potential rate calculated for bare soil. When a threshold amount, U, is reached, hydraulic properties of the soil begin to limit the evaporation rate. According to Ritchie (29), second stage evaporation is calculated by

$$Es = c't^{\frac{1}{2}} - c'(t-1)^{\frac{1}{2}} \qquad (16)$$

where Es is the stage 2 evaporation, c' is a hydraulic coefficient of the soil, and t is the time after stage 1 evaporation.

Field work done by Kanemasu (14) using these relations have supplemented Ritchie's work, providing the values for U and c' shown in Table 3. Studies conducted by Bond (2) lead to similar relations using cumulative evaporation

TABLE 3. SOIL MOISTURE PROPERTIES USED IN THE MODEL

(1)	(2)	(3)	(4)		(5)		(6)		(7)		(8)	(9)
Irrigation soil class	SCS soil group	Soil profile depth ft	Available water inches		Field capacity inches		Permanent wilting point inches		Soil moisture at saturation inches		Upper limit stage 2* evapor. U in.	Empirical coeff. c' in. day$^{-\frac{1}{2}}$
			Upper* zone	Lower† zone	Upper zone	Lower zone	Upper zone	Lower zone	Upper zone	Lower zone		
1	D	3.0	2.6	2.7	4.6	9.4	2.0	6.7	5.8	11.8	0.47	0.20
2	D	3.0	1.5	2.9	4.4	9.4	2.9	6.5	6.2	11.5	0.47	0.20
3	C	5.0	2.5	5.7	4.5	14.2	2.0	8.5	5.7	16.3	0.39	0.18
4	C	2.5	2.4	2.5	4.6	7.0	2.2	4.5	5.7	8.2	0.39	0.18
5	B	5.0	2.5	6.7	4.5	13.9	2.0	7.2	5.7	15.8	0.39	0.18
6	B	3.0	2.6	4.2	4.3	9.1	1.7	4.9	5.5	10.4	0.39	0.18
7	B	5.0	2.4	6.6	4.0	13.7	1.6	7.1	5.4	15.4	0.35	0.16
8	B	2.5	2.4	3.3	4.0	6.8	1.6	3.5	5.4	7.7	0.35	0.16
9	B	5.0	2.4	5.2	3.8	9.2	1.4	4.0	5.3	13.9	0.31	0.14
10	B	5.0	2.2	4.1	3.5	7.0	1.3	2.9	5.2	13.2	0.31	0.14
11	B	5.0	1.5	4.1	2.3	7.0	0.8	2.9	4.8	13.2	0.28	0.13
12	A	5.0	1.0	2.5	1.7	4.3	0.7	1.8	4.8	12.9	0.24	0.13

*Upper zone thickness is 1 ft.

†Lower zone thickness is 3 ft except where soil profile depth limitations occur.

curves. The model treats both stage 1 and stage 2 evaporation in the same manner as Ritchie and Kanemasu. The 12 soil classes in Table 3 apply to the irrigation design class descriptions listed in Table 4 (15).

Evapotranspiration

The rate of consumptive use of a crop is dependent upon atmospheric, plant, and soil factors (13). The atmospheric or climatic factors are incorporated in the computation of PET by the Penman method. The Blaney-Criddle method (32) is widely accepted in accounting for plant factors. This method is used to modify the potential rate by a plant consumptive use factor (k) which is determined from experimental data for each crop. The method has been applied to both dry land (42) and irrigated (12) crops.

Under wet conditions evapotranspiration will proceed at the maximum rate. This relation continues until the soil-water deficit reaches a level which is equivalent to 0.3 of the maximum available moisture θ_{max}, according to Kanemasu (14). Available moisture, or capillary water as defined by Israelsen (11, p. 162), is the moisture content of the soil between field capacity and the permanent wilting point. When the soil-water deficit falls below 0.3 θ_{max}, Kanemasu modifies the potential rate by the simple linear relation

$$Ks = \theta a/0.3\ \theta_{max} \tag{17}$$

where θa is the actual available soil moisture content. Ks = 1 when the soil moisture is a above 0.3 θ_{max} and varies linearly from 1 to 0 between 0.3 θ_{max} and the permanent wilting point. The actual evapotranspiration (AET) is then

$$AET = PET \times k \times Ks \tag{18}$$

A discussion of crop coefficients, k, can be found in Appendix A in the section relating to the (CROPCO) subroutine. The required inputs are crop type, and the planting and harvesting dates for winter wheat, grain sorghum, corn, soybeans, pasture, alfalfa and fallow.

Surface Runoff, Interception, and Infiltration

The Soil Conservation Service method (10) is widely accepted for predicting the total volume of surface runoff produced by a design storm. The equation takes the form

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} \tag{19}$$

where Q = direct surface runoff, P = precipitation, and S = the maximum potential difference between precipitation and runoff, all inches. The initial abstraction, IA = 0.2S, which consists of surface storage, interception losses, and water which infiltrates into the soil prior to runoff, must be satisfied before surface runoff can occur.

The SCS method involves assigning runoff curve numbers to specific ante-

TABLE 4. IRRIGATION DESIGN CLASS DESCRIPTIONS FOR SOILS IN THE DISPOSAL AREA (From Kansas Irrigation Guide (15))

Irrigation soil class	Profile depth ft	Soil class description
1	3.0	Deep soils with silt loam or silty clay loam surface layers and slowly to very slowly permeable heavy clay and claypan subsoils.
2	3.0	Deep soils with silty clay or clay textures throughout. Surface infiltration and subsoil permeability are very slow when the soil is moist. Shrinkage from drying causes extensive cracking, resulting in high infiltration rates until swelling occurs.
3	5.0	Deep soils with silt loam, loam, clay loam, or silty clay loam surface layers and clay loam, silty clay loam, or silty clay subsoils. Subsoil permeability is slow to moderately slow. Shrinkage cracks resulting from drying in the soils with more clayey subsoil textures give a relatively high initial infiltration rate.
4	2.5	Moderately deep soils with silt loam, clay loam, or silty clay loam surface layers and clay loam or silty clay subsoils with predominantely moderately slow permeability.
5	5.0	Deep soils with silt loam, loam, clay loam, or silty clay loam surface layers and subsoils. Subsoil permeability: moderate to moderately slow.
6	3.0	Moderately deep soils with silt loam or loam surface layers and loam, clay loam, or silty clay subsoils with moderate to moderately slow permeability.
7	5.0	Deep soils with silt loam, loam or very fine sandy loam surface layers and moderately permeable, medium textured subsoils.
8	2.5	Moderately deep soils with silt loam, loam or very fine sandy loam surface layers and moderately permeable clay loam, loam, or silt loam subsoils.
9	5.0	Deep soils with fine sandy loam and loam surface layers and subsoils that have moderately rapid permeability. Available water capacity is moderate to low.
10	5.0	Soils are moderately deep over sand with sandy loam to loam surface layers and moderately rapid to rapidly permeable subsoils with low available water capacity.
11	5.0	Deep soils with loamy fine sand or loamy sand surface layers and moderately rapid to rapidly permeable subsoils.
12	5.0	Deep rapidly permeable soils with sand or fine sand textures throughout.

cedent moistures, soil types, and land use and conservation practices. The runoff curve numbers (N) used in the model are shown in Table 5. They are

TABLE 5. SCS RUNOFF CURVE NUMBERS FOR CONDITION II*

Soil class	Row crops	Alfalfa	Wheat	Pasture	Fallow
1	86	83	84	80	84
2	86	83	84	80	84
3	82	78	81	74	78
4	82	78	81	74	78
5	75	69	73	61	69
6	75	69	73	61	69
7	75	69	73	61	69
8	75	69	73	61	69
9	75	69	73	61	69
10	75	69	73	61	69
11	75	69	73	61	69
12	65	55	61	39	61

*Condition II - During the growing season, available soil moisture in the top 1 ft is between 0.5 and 0.8 of field capacity. For the non-growing season, the range is 0.6 to 0.9 of field capacity.

specified by crop type and the selected range of soil (15) types defined in Table 4. The input N (10) is based on condition II antecedent moisture. For the soil moisture accounting model, condition II is an upper zone soil moisture between 0.5 and 0.8 of field capacity during the growing season or between 0.6 and 0.9 of field capacity during the dormant season. When the soil moisture is less than 0.5 or 0.6 of field capacity, depending upon the season, N is assumed to be a condition I antecedent soil moisture given by

$$N_I = N \times 0.39e^{(-0.009 \times N)} \tag{20}$$

When the soil moisture is greater than the upper limit set for the season, the condition III curve number is obtained by the equation

$$N_{III} = N \times 1.95e^{(-0.00663 \times N)} \tag{21}$$

Then by definition

$$S = \frac{1000}{N} - 10 \tag{22}$$

and S is substituted into equation 19 to calculate the runoff volume.

The interception-storage is fixed at 0.1 in. and depleted at the potential free surface evaporation rate. According to Ward (37), this storage should account for 10 to 20 percent of the annual precipitation. Of the previously tested Kansas and Oregon stations, approximately 16 to 18 percent of the annual precipitation was accounted as interception-storage losses. After runoff and interception amounts are deducted, the remaining excess precipitation infiltrates into the soil.

Percolation and Redistribution

The percolation rate and redistribution of the infiltrated water within the soil profile is dependent upon the hydraulic properties of the soil (11, p. 152). Saxton (31) has modeled percolation by means of physical redistribution. Using this scheme, a soil layer is allowed to take on an equivalent amount of water to raise storage to a level of 0.9 saturation with the excess being cascaded to the next layer. This continues until all water available for percolation is stored. Movement of gravitational water is then computed by the one-dimensional Darcy equation for unsaturated flow using moisture-tension and moisture-conductivity relationships.

Redistribution is similar in this model, but simplified. Since the field capacity of a soil is generally evaluated two days after saturation (11, p. 163) the model allows upper zone soil moisture to decrease to field capacity in two days if it is not already below that level as a result of AET needs. This is accomplished by setting the soil moisture equal to field capacity and redistributing the excess to the lower zone. Since the lower zone generally does not receive water as a result of small events, greater periods of time pass between recharges. When left undisturbed for more than two days, soils usually achieve a moisture level which is less than field capacity. Accordingly, the lower zone soil moisture is decreased to 0.9 of field capacity when the time between recharges exceeds two days, and the excess is considered to percolate out of the root zone. This modified method appears to result in reasonable estimates of vertical movement of water for the soil groups tested. The soil moisture properties for the 12 soil classes programmed into the model are listed in Table 3.

Snow on the Disposal Area

A degree-day approach of dissipating accumulated snow is incorporated to simulate winter conditions on the disposal area. Approaches such as presented by Leaf (19) based on thermodynamic principles are good representations of actual snow physics, although input requirements limit widespread application. Empirical equations developed to approximate the thermodynamic principles are simpler but generally provide less satisfactory results (21, p. 275). The degree-day approach stands only on the virtue of simplicity in that it requires only the dry-bulb temperature as input. The method has the disadvantage of neglecting humidity, radiation, and other factors which influence snow melt, although good results have been obtained (20).

Precipitation occurring on days having an average temperature $\leq 32°F$ were accumulated as water equivalents of snow. The snow melt function used in this model as presented by Gray (9, pp. 9.12-9.14) is

$$M = C(Ta - Tb) \qquad (23)$$

where M is the snow melt, Ta = the mean daily atmospheric temperature, Tb = the base temperature, and C = the degree-day coefficient. This computes snow melt as a result of atmospheric conditions. If the snow is initially considered to be at 32°F, then the relation used by Linsley (20) to compute snow melt by rainfall is

$$D = (1/144)(P)(Ta - 32) \tag{24}$$

where D = the snow melted by rainfall, P = the amount of rainfall, and Ta = the mean daily temperature. The total snow melt runoff (M + D) is added to the precipitation and wastewater applied for the day to obtain P in Eq. (19).

Evaporation from snow (sublimation) works basically on the same principles as evaporation from a free water surface (9, pp. 3.7-3.8). Approximately 5 percent of incident shortwave radiation is reflected from a free water surface, while from 80 to 90 percent is reflected by a clean, dry snow surface. Because of changes in crystalline structure, density, and the amount of dirt on the surface, the albedo drops to 50 percent or less as snow ages. An average albedo, r, of 70 percent is used when applying the Penman equation to a snow surface in this model. It is also assumed that a water equivalent of 0.1 in. in the pack provides sufficient cover to treat the evaporation calculation in terms of a snow surface. The resulting daily sublimation from the pack is small, generally less than 0.01 in., but through the winter months this may account for some dissipation of the pack.

Criteria for Disposal on the Area

Water from the storage facility will not be applied on the disposal area under the following conditions:

1) when there is less than one day's irrigation water in the facility,
2) when the ground is frozen,
3) when the mean daily temperature < 32°F, and
4) when the upper zone soil moisture is greater than a specified percentage of maximum available moisture.

The soil is considered to be frozen if the sum of the previous two days temperature < 64°F. Thawing occurs when the sum of the average temperatures for any three consecutive day period is > 114°F.

The percentage of upper zone available moisture, PAVLU, defines the fourth condition for irrigation. It allows various irrigation management schemes to be tested. By setting PAVLU = 0.0, a non-irrigation or pure retention pond surface evaporation system can be tested. PAVLU = 0.90 tests an intensive application of water, while PAVLU = 0.50 tests a normal irrigation management scheme. The available moisture for the 12 soil classes is listed in Table 3.

FEEDLOT RUNOFF

Feedlot surfaces differ greatly from disposal area surfaces. Repeated animal milling works the surface, compacting underlying soil layers. As a result, normal infiltration is impaired and influenced by the development of the lot. Difficulties arise when attempting to apply normal surface runoff models to a feedlot.

Models incorporating the SCS method to predict feedlot runoff volume have been tested in Kansas (16), Oregon (39), and Minnesota (18). Reasonable results have been obtained by using curve number (N) varying from 91 to 98 depending on surface type and antecedent conditions. General agreement exists that N = 91 is satisfactory for antecedent conditions I and II, and N = 97 is satisfactory for condition III on unsurfaced lots.

With very limited feedlot runoff data from feedlots at Gretna, Nebraska (36), Bushland, Texas (6), and Pratt, Kansas (22), a modified version of the SCS method was developed. Attempts to evaluate runoff curve numbers using the soil-moisture deficit of the surface provided less satisfactory results than a simpler model used by Koelliker (16). Studies by Miner (23) and Swanson (36) suggest that rainfalls of certain intensity and duration are required before any runoff occurs from the feedlot surface. Also, SCS calculated runoff quantities from large rainfall events significantly underestimate the actual runoff. Since infiltration is impeded in a developed lot, it is assumed that any precipitation above an amount required to fill depression storage and saturate the soil above the impervious layer would run off. Various rainfall magnitudes were tested to determine the minimum storm required to produce runoff.

The model which eventually provided the best results specifies that surface runoff will not occur if

1) the 3-day antecedent moisture and the precipitation on the day of concern is < 0.5 in.,
2) the average temperature for the day < 30°F, and
3) the soil is frozen.

While the ground is frozen, all precipitation is accumulated as snow on the feedlot. When the soil thaws, the accumulated volume of snow is allowed to run off with N = 97. Snow on the feedlot is handled differently than on the disposal area because of major differences in two surfaces. In most parts of the U.S., a volume nearly equivalent to the accumulated winter precipitation quantity is retained in the storage facility during the course of the season. Even at high N, routing small melts during winter months through the SCS equation would result in a significantly smaller volume. Urine addition by confined animals compensates for sublimation losses from snow and may account for differences discussed. Irrigation is generally unfavorable in winter so the timing of additions to the pond is not as important as the volume accumulated during the season.

Best results are obtained by partitioning the year into a growing season and dormant season; April-October and November-March, respectively. During the growing season, a maximum of 1.25 in. (variable GROW in FROMKSU) is routed through the SCS equation with N = 97 if the 3-day antecedent moisture is > 0.75 in. or N = 91 if the antecedent moisture ≤ this amount. For any day having an event > 1.25 in., the excess is considered to run directly off the feedlot surface. During the dormant season, the maximum precipitation routed through the SCS equation is lowered to 1.0 in. (variable DORM in FROMKSU) and N = 91 is used when 3-day antecedent moisture < 0.5 in. Otherwise, N = 97 is used during this season.

A regression analysis between calculated values of feedlot runoff and actual data resulted in a normal range of r^2 values between 0.80 and 0.85 on unsurfaced lots. At the present time no attempts to simulate surfaced lots have been made since there is a lack of actual data for this type. The regression analysis provides some justification for the procedures used in modeling the feedlot runoff.

THE STORAGE FACILITY

A runoff control structure generally resembles an inverted frustrum of a pyramid. The configuration of the general prismatoid in Figure 4, allows independent variations of base length (L), base width (W), and side slopes (S), to be used in the model. These parameters along with the maximum depth of water (HMAX) are input variables to the program and define the maximum volume of water which the facility can contain before discharging. By specifying a particular size and shape of pond, the surface area and the evaporation can be computed for any storage volume. The volumetric equation for a general prismatoid (33) is

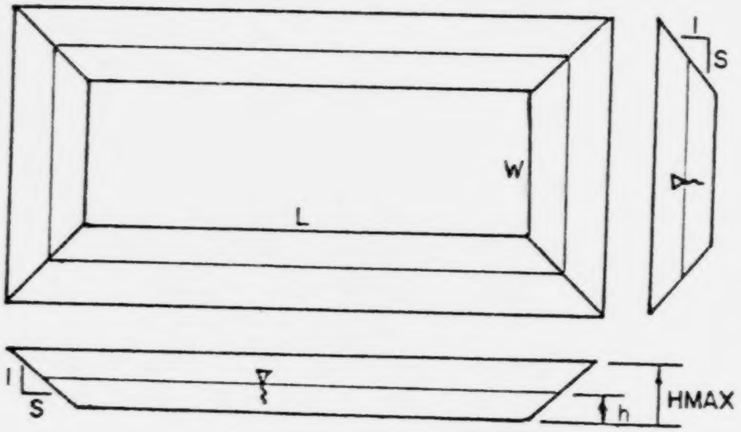

Figure 4. Configuration of storage facility.

$$V = \frac{1}{6} h \, (B1 + 4Bm + B2) \qquad (25)$$

where V = the volume, h = the depth, B1 = the bottom surface area, B2 = the top surface area, and Bm = the area of a plane at h/2 above the bottom.

Feedlot runoff contains a high suspended solids load which impedes seepage from the storage facility. Although seepage may continue for certain soils and for facilities which experience wet/dry cycles, no verified exfiltration rates are available. A sealed condition or zero exfiltration is, therefore, assumed for the pond. The inputs to the facility include runoff from the feedlot and direct contributions of precipitation to the receiving area which is the pond surface area at HMAX. Outflows consist of water pumped out for irrigation purposes, surface evaporation, and overflows.

SECTION 5

TESTING PROCEDURE

The feedlot model was calibrated and tested on 10 stations in Kansas and 18 other stations distributed throughout the United States. Stations which have at least 25 years of daily rainfall and maximum and minimum temperatures on magnetic tape (obtained from the National Climate Center, Asheville, North Carolina) were used.

A standard run was tested for each station. The standard run consisted of a 40-ac feedlot, 80-ac disposal area, corn crop on the disposal area, Soil Type 5 as determined by the Kansas Irrigation Guide (15), irrigation disposal rate of 0.50 in./day (over disposal area), irrigation management in which disposal is allowed whenever soil moisture falls to 0.9 of available moisture in the upper zone, and a maximum pond depth of 9 ft. Crop growth coefficients (Blaney-Criddle) were adjusted to correspond to the particular location, as described in Appendix A. A 3:1 pond side slope was used for all runs. The pond length to width ratio varied from 2:1 to 1:1 (the effect of this parameter on results is negligible).

For the initial run for a station, the pond dimensions were estimated to provide 100 percent control. The dimensions were then adjusted until 100 percent control of the feedlot runoff was maintained for at least a 25-year simulation period.

The standard runs were specifically designed to test the influence of climate (precipitation and temperature) on facility needs. Other variables effect the size of the pond for 100 percent control. These include feedlot area, maximum pond depth, disposal area, soil, crop, disposal rate, and disposal management. (Disposal management always refers to the percentage of the upper zone available moisture at which irrigation disposal is allowed). Each of these parameters was varied using otherwise standard conditions to determine the relative magnitude of variations upon pond size. This was accomplished by varying the pond size until 100 percent control was achieved. The ratio of the pond size to "standard" pond size was designated as the "design factor" for the variable.

For the 20 stations which have positive moisture deficits, an evaporation disposal system was also tested. An evaporation system is simulated by setting the disposal management parameter PAVLU to zero, which eliminates irrigation disposal. Thus the only disposal from the pond is by evaporation. The maximum pond depth was set at six feet for these runs, and the pond dimensions adjusted until 100 percent of feedlot runoff was controlled. Since irrigation was not allowed on the disposal area, the moisture accounting for the disposal area reduces to a natural accounting which provides useful information for examining relative effects in calibrating the model.

The pond surface area rather than pond volume is the important dependent variable for the evaporation testing. The standard run results for the 28 stations tested are given in Table 6. PONVOL is the pond volume required for 100 percent control of runoff when a land disposal site is utilized. SURF is the surface area for 100 percent control for stations which could conceivably be operated as simple evaporation systems. The base period for testing was normally 25-28 continuous years of the time interval 1948-1975. Other time periods were used when problems were experienced with the magnetic tape data for the base period. Sacramento was the only station not having a continuous 25 year record.

TABLE 6. CLIMATOLOGICAL VARIABLES AND STANDARD RUN RESULTS FOR IRRIGATION AND EVAPORATION DISPOSAL

Station	No.[a]	Lake evap. in.	Prec. in.	MD[b] in.	PONVOL[c] ac-in	PREVAP[d] -	SURF[e] ac	Period of record	Total years
Phoenix, AZ	1	71	7	64	110	0.10	1.9	49-75	27
Bakersfield, CA	2	88	5	83	31	0.06	0.9	48-75	28
Sacramento, CA	3	56	18	38	609	0.32	12.1	30-72[h]	35
Dublin, GA	4	35	45	-10	1081	--	--	49-73	25
Boise, ID	5	42	11	31	195	0.26	4.4	49-70	22
Urbana, IL	6	36	39	- 3	615	--	--	27-51	27
W. Lafayette, IN	7	34	37	- 3	1017	--	--	11-35	25
Belleville, KS	8	41	30	11	355	0.73	47.9	49-73	25
Colby, KS	9	55	18	37	173	0.33	8.6[f]	50-74	25
Dodge City, KS	10	62	21	41	193	0.34	8.6	49-73	25
Ellsworth, KS	11	45	27	18	385	0.60	20.4	46-70	25
Garden City, KS	12	60	13	42	170	0.30	7.2[g]	50-74	25
Goodland, KS	13	51	16	35	145	0.31	4.6	49-73	25
Hays, KS	14	58	23	35	285	0.40	12.6	48-73	26
Horton, KS	15	37	37	0	689	--	--	46-70	25
Independence, KS	16	43	36	7	363	0.84	62.4	48-72	25
Topeka, KS	17	44	34	10	681	0.77	52.8	49-73	25
Crookston, MN	18	26	19	7	562	--	--	18-42	25
Min.-St. Paul, MN	19	34	26	8	550	--	--	49-73	25
Las Vegas, NV	20	85	4	81	75	0.05	1.3	49-73[i]	25
Wooster, OH	21	31	39	- 8	2215	--	--	01-25	25
Okla. City, OK	22	55	31	24	379	0.56	24.6	48-75[j]	28
Corvallis, OR	23	28	39	-11	1862	--	--	31-65	35
Pendleton, OR	24	42	13	29	120	0.31	2.8	45-69	25
Centerville, SD	25	37	24	13	502	0.65	32.3	49-73	25
Beeville, TX	26	47	30	17	1094	0.64	48.4	51-75	25
College Stat., TX	27	56	40	16	535	0.71	47.9	21-45	25
Hereford, TX	28	64	17	47	234	0.27	6.8	49-73	25

[a] Numbers identify stations on Figs. 5, 6, and 7.

[b] Moisture Deficit = Lake Evap. - Prec.

[c] 100 percent control volume for standard run (40-ac feedlot) with irrigation disposal.

[d] PREVAP = Prec. ÷ Lake Evap.

[e] 100 percent control surface area for disposal by evaporation (40-ac feedlot and 6 ft pond depth).

[f] Colby evaporation simulation period is 1900-74 (75 yrs).

[g] Garden City evaporation simulation period is 1915-74 (60 yrs).

[h] Eight years of data missing in middle of this record. Discontinuous run.

[i] Alfalfa substituted for corn as standard crop.

[j] Type 3 soil substituted for Type 5 soil as standard crop.

SECTION 6

RESULTS AND DISCUSSION

IRRIGATION DISPOSAL

The pond volume for 100 percent control is usually 1.5 to 3 times that required to impound the P25 critical event. Table 7 compares the 100 percent control size to the pond volume required to store the P25 event for a 40-acre feedlot. The frequency of occurrence of this event (or greater) for the simulation period for each run is also listed. Because the total record length is 726 years and the probability of at least a P25 event occurring during any random 25 year period is 64 percent, the expected frequency of occurrence of this event is 19. The actual frequency of 21 indicates that P25 estimates obtained from rainfall frequency charts were reasonably representative. It is possible that the P25 values for Crookston, MN, and Wooster, OH, are low since they registered six and four P25 events during the record period, respectively. An increase in Crookston P25 of 0.3 in. eliminates three of the six critical events. Otherwise, this station had a normal climate pattern, so that the P25 selected for this station may have been somewhat low. Wooster, OH, is different in that it appears to have experienced abnormally wet conditions during the 1901-1925 simulation period. The pond volume required for this station is 20 percent higher than the next highest station. It should be noted that P25 was used only as an indicator and did not alter the budget computations in any way. Thus, the choice of P25 was not critical except to determine the relevance of the event to designing a feedlot runoff control system.

Table 7 also shows that the 100 percent control volume is larger than the P25 volume except for the arid climate stations. Although 21 P25 events were registered, in only one case did a pond discharge coincide with the date of the P25 event. In six other cases a pond discharge occurred within two months of the P25 event. But because the pond size for these cases ranged from 1.8 to 3.5 times the P25 size, the P25 event never singularly controlled the size of the pond for any station at any time. Occasionally antecedent wet conditions caused the pond to be full enough prior to the P25 event to cause an overflow shortly thereafter. Figure 5 indicates that there is almost no correlation between P25 and the 100 percent control pond volume for the 28 stations tested, although six arid to semiarid stations in Table 7 (1, 2, 9, 12, 13, 20) had 100 percent control volumes less than the P25 volume. The explanation for this seeming contradiction is that only one of these stations experienced a P25 event, and that the feedlot runoff algorithm never yields 100 percent runoff from a given precipitation event. It thus follows that the P25 event is an insufficient criteria for the design of feedlot runoff control facilities and that so-called "chronic" conditions profoundly influence the size of facilities.

TABLE 7. COMPARISON OF CRITICAL EVENT (P25)[a] TO 100 AND 96 PERCENT CONTROL POND VOLUMES

Station	No.	P25 frequency	P25 event in.	P25[b] volume ac-in	100%[c] volume ac-in	Ratio 100%/P25	96%[d] volume ac-in
Phoenix, AZ	1	0	4.5	184	110	0.6	44
Bakersfield, CA	2	0	3.4	136	31	0.2	12
Sacramento, CA	3	1	8.1	324	609	1.9	244
Dublin, GA	4	0	7.3	292	1081	3.7	432
Boise, ID	5	1	2.7	108	195	1.8	78
Urbana, IL	6	0	5.0	200	615	3.1	246
W. Lafayette, IN	7	0	4.9	196	1017	5.2	407
Belleville, KS	8	2	5.1	204	355	1.7	142
Colby, KS	9	0	4.5	180	173	1.0	69
Dodge City, KS	10	1	4.6	184	193	1.1	77
Ellsworth, KS	11	1	5.4	216	385	1.8	154
Garden City, KS	12	0	4.5	180	170	0.9	68
Goodland, KS	13	0	4.3	172	145	0.8	58
Hays, KS	14	1	4.7	188	285	1.5	114
Horton, KS	15	1	5.9	236	689	2.9	276
Independence, KS	16	0	6.7	268	363	1.4	145
Topeka, KS	17	0	6.1	244	681	2.8	272
Crookston, MN	18	6	4.1	164	562	3.4	225
Minn.-St. Paul, MN	19	0	4.8	192	550	2.9	220
Las Vegas, NV	20	1	2.7	108	75	0.7	30
Wooster, OH	21	4	3.9	156	2215	14.2	886
Okla. City, OK	22	1	6.9	276	379	1.4	152
Corvallis, OR	23	0	6.8	272	1862	6.8	745
Pendleton, OR	24	0	2.3	92	120	1.3	48
Centerville, SD	25	0	4.7	188	502	2.7	201
Beeville, TX	26	0	8.1	324	1094	3.4	438
College Stat., TX	27	0	8.4	336	535	1.6	214
Hereford, TX	28	1	4.9	196	234	1.2	94
		Σ=21					

[a] P25 is the 25-yr, 24-hr storm in inches.

[b] Pond volume for 40-ac feedlot = P25 x 40.

[c] Pond volume required for 100 percent control under standard conditions (PONVOL).

[d] Pond volume required for 96 percent control under standard conditions = 100 percent Vol. x 0.4.

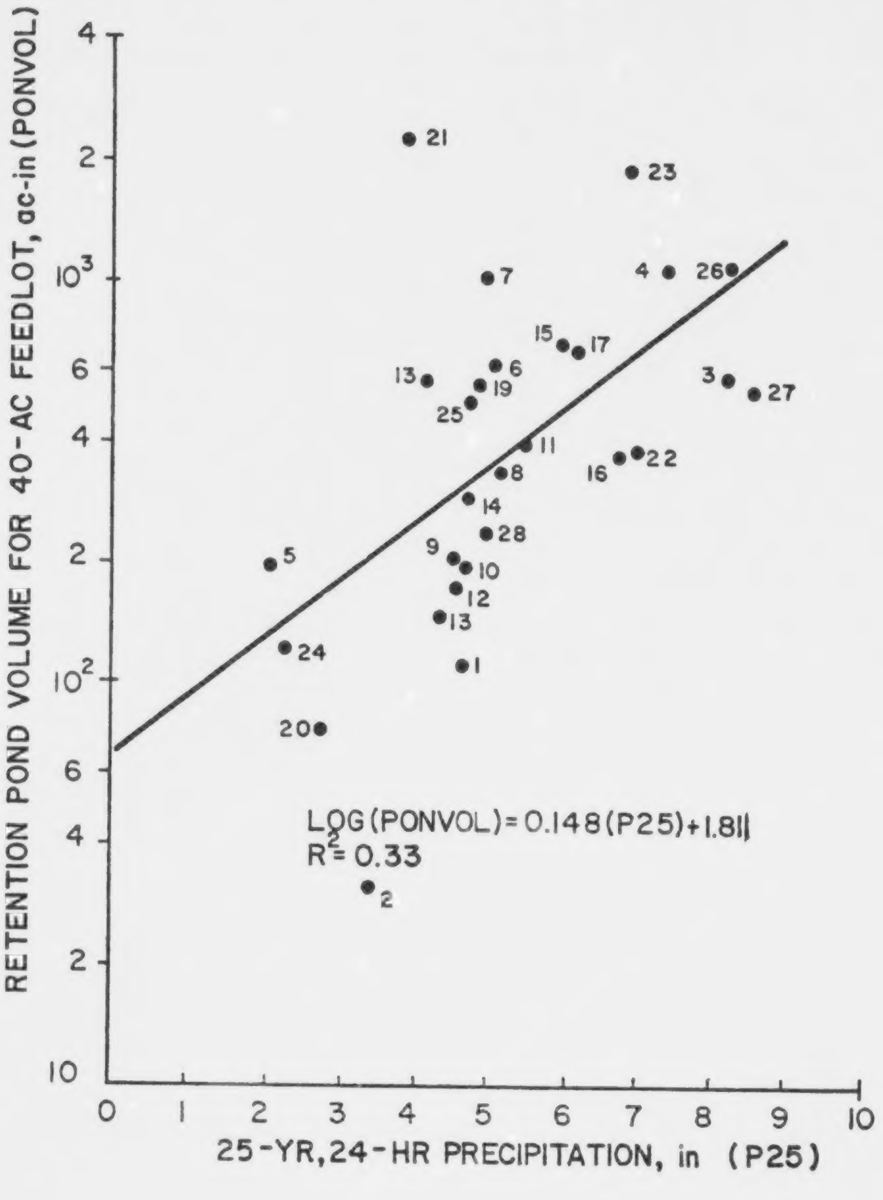

Figure 5. The 100 percent control volume as a function of the 25-yr. storm.

In order to generalize the results of this study and to provide a more appropriate guideline for the sizing of this type of facility, regression analyses were performed with a number of selected climatic indices. The detailed results are listed in Appendix C. From this analysis it became clear that the moisture deficit (MD) is the single climatic variable that is the most readily available and provides the highest correlation for any single parameter. The results of this regression are plotted on Figure 6. In the absence of historical data, and/or computer facilities, Figure 6 allows one to obtain an estimate of the 100 percent control volume at any location under standard conditions. The equation of the line is:

$$\text{Log}_{10}(\text{PONVOL}) = 2.910 - 0.0150\ \text{MD} \qquad (26)$$

where PONVOL = 100% Control Pond Volume for a 40-ac feedlot (and other "standard" conditions) in acre-inches; and MD = moisture deficit in inches.

EVAPORATION

The required pond surface area for the 20 stations operated as simple evaporation disposal systems are listed in Table 6. Regression analyses performed on these data with various climatic indices are also given in Appendix C. The climatic index that has the highest correlation and is the most readily available is the ratio of mean annual precipitation to mean annual lake evaporation (PREVAP). The regression equation is:

$$\text{Log}_{10}\ \text{SURF} = 0.091 + 2.166\ \text{PREVAP} \qquad (27)$$

in which SURF = 100% Control Pond Surface Area for a 40-ac feedlot in acres; and PREVAP = ratio of annual precipitation to evaporation. The standard conditions for the evaporation runs, in addition to the 40-ac feedlot, included 3:1 sideslopes and an HMAX = 6 ft. Thus, the pond surface area also implies a minimum pond volume to achieve 100 percent control, as listed in Table 6. The regression line is plotted in Figure 7.

METHOD FOR SIZING COMPONENTS

A prediction equation similar to that developed by Beasley (1) is used to determine the volume of a retention pond required at a specific feedlot for an irrigation-disposal system. The equation is,

$$\text{RPV} = \text{PONVOL} \times \text{SR} \times \text{S} \times \text{C} \times \text{D} \times \text{R} \times \text{H} \times \text{M} \times \text{PRC} \qquad (28)$$

where RPV = retention pond volume for the specific feedlot, acre-inches
PONVOL = 100% control retention-pond volume for the specific location under standard conditions, acre-inches (Fig. 6 or Eq. 26)
SR = ratio of the site specific feedlot size to the 40 acre standard run size
S = soil type factor
C = crop factor
D = disposal area to feedlot area ratio factor
R = disposal rate factor
H = maximum pond-depth factor

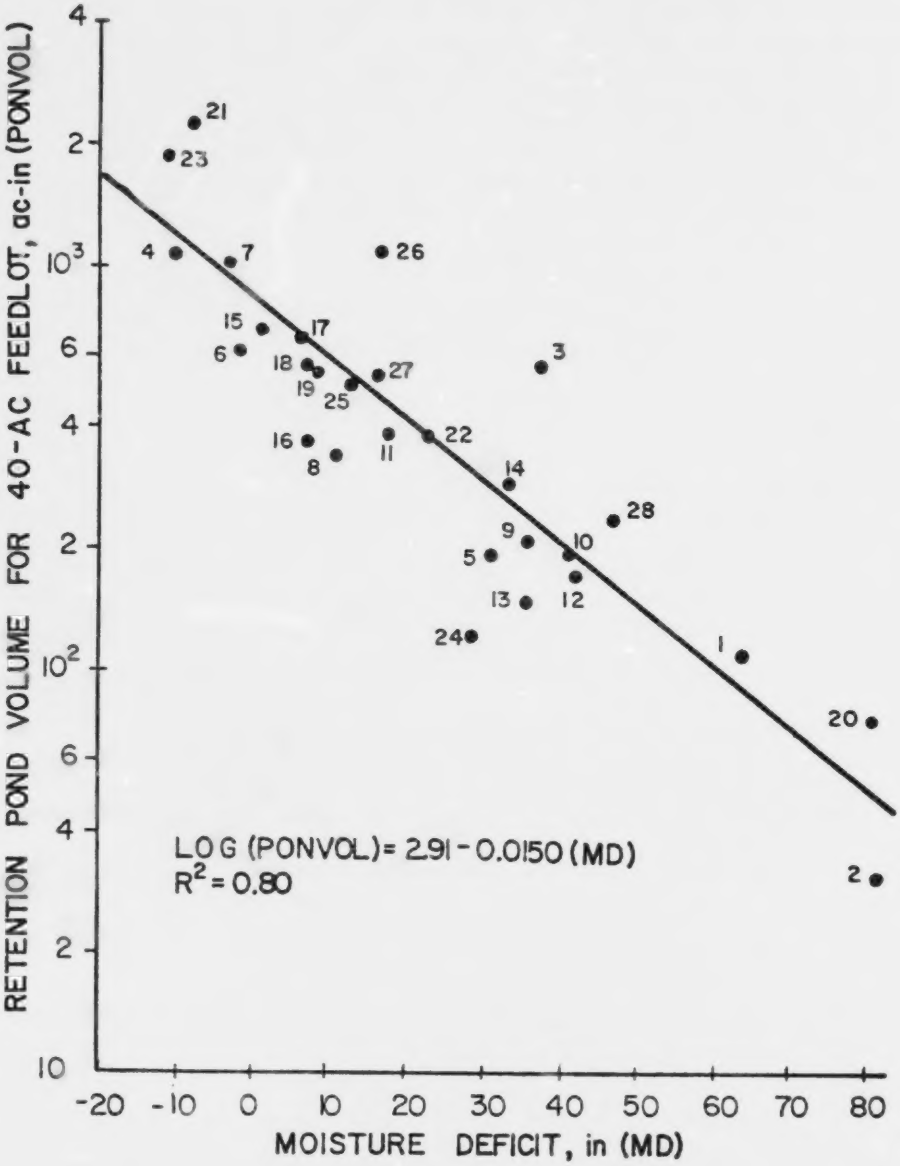

Figure 6. The 100 percent control volume as a function of moisture deficit.

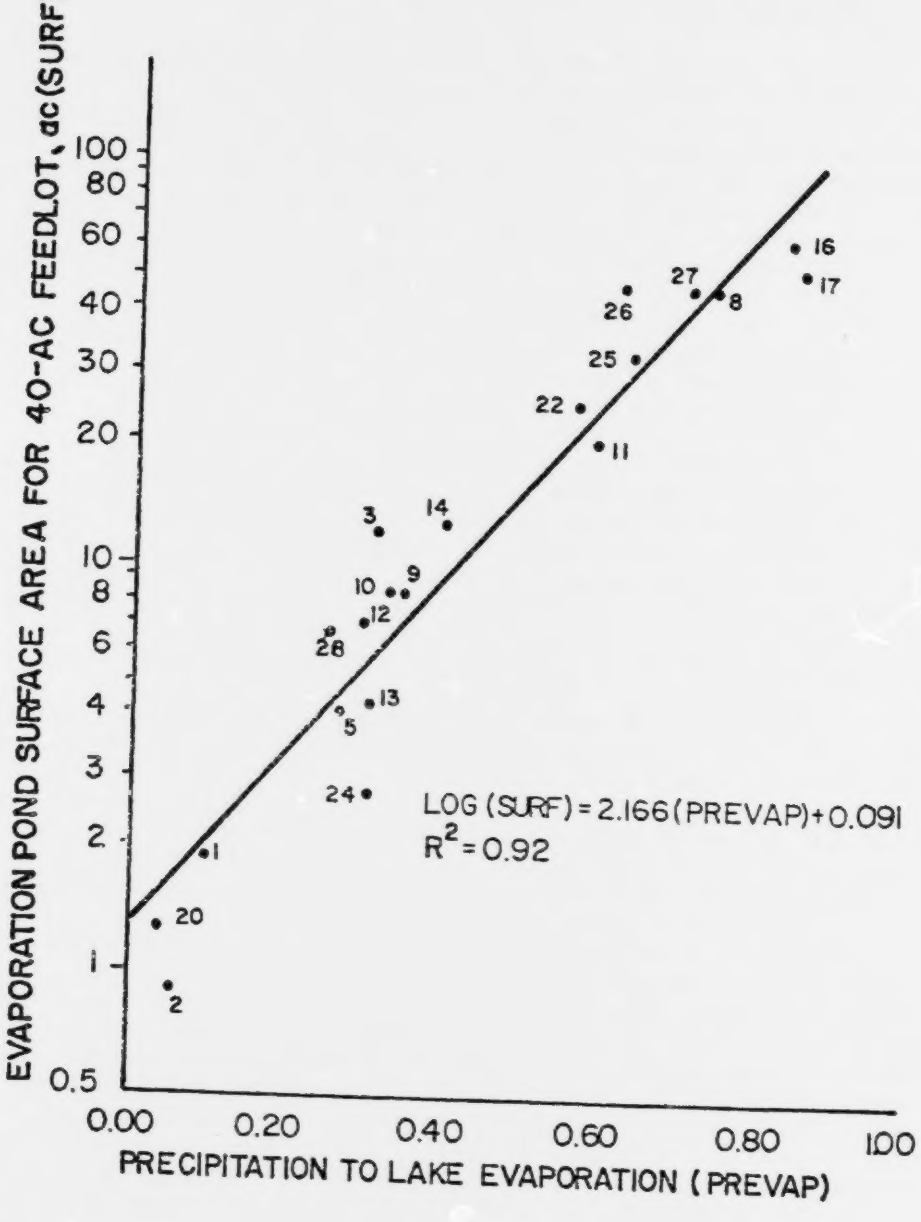

Figure 7. The 100 percent control surface area for evaporation systems as a function of PREVAP.

M = irrigation disposal-management factor
PRC = percentage of runoff-controlled factor

The standard runs were used to determine the effects of climate on the sizing of runoff-retention ponds with or without (evaporation) land systems. These runs were restricted to one feedlot size soil and crop type disposal management practice, disposal area size, irrigation disposal rate and management practice and retention pond depth. By repetitive runs each time changing only one of these variables, the coefficients in Eq. 28 can be obtained by computing the ratio of pond size required for the variation run to the standard run. The coefficients thus developed are listed in Tables 8 through 13. It would have been exceedingly costly to make a variable change of every variable for all stations. More than 300 computer runs were made, however, which allowed an approximate determination of these coefficients. Included in Tables 8 through 13 are the standard deviations and number of runs for each coefficient along with its average value.

"PRC" is a factor for the percentage of runoff that must be controlled by the system. It has a substantial effect upon the size of pond required. The ratio of pond size to 100 percent control size, PRC, is plotted against the actual percentage of runoff controlled in Figure 8 for the 28 runs which resulted in less than 100 percent control. This curve, the regression equation noted on Figure 8, or the rounded values in Table 14 can be used to determine PRC for any percentage of control desired. In no case should the curves be extrapolated for a percentage of control less than 94 percent.

There is a substantial reduction in pond size for the "nearly" 100 percent control values of 98 or 99 percent in Table 14. At 97 percent control the pond volume is approximately one-half that required for 100 percent control. The 96 percent control column in Table 7 is included for comparison. The 96 percent volume is obtained by multiplying the 100 percent control volume by a PRC = 0.4 for 96 percent control from Table 14. The 96 percent control volume is greater than P25 design volume for 11 stations in Table 7. Thus, if the performance standard were restated as "P25 volume or the 96 percent volume, whichever is greater", the P25 performance criteria would govern approximately 60 percent of the cases, while the 96 percent critera would govern the other 40 percent. The 96 percent factor has a probability equal to that of the P25 event, although P25 is based upon frequency of occurrence while 96 percent control is based upon total volume. It is used here as an example. If 98 percent control was to be accepted as a reasonable level of performance for feedlots in addition to P25, half of the 28 stations tested would be governed by the 98 percent criteria and the other half by P25. If, conversely, P25 were used as an exclusive criteria, the average level of control for the 22 stations for which the 100 percent control size was greater than the P25 volume, is approximately 97 percent. Several of the humid climate stations in Table 7 (7, 21, 23) have ratios of P25 to 100 percent too low to evaluate using Figure 8, so these stations were not averaged in to the above figure of 97 percent.

TABLE 8. DESIGN FACTOR S FOR SOILS IN DISPOSAL AREA

Soil type	S	Std. dev.	No. of runs
1	0.97	0.04	6
2	0.95	0.15	8
3	0.96	0.09	10
4	0.96	0.14	6
5	1.00	Standard	27
6	0.98	0.14	8
7	0.99	0.03	7
8	0.99	0.03	5
9	1.00	0.04	7
10	0.92	0.13	5
11*	0.84	0.09	6
12*	0.76	0.15	7

*Values for these soils should be used cautiously; groundwater contamination from percolating water should be assessed.

TABLE 9. DESIGN FACTOR C FOR CROP ON DISPOSAL AREA

Crop	C	Std. dev.	No. of runs
Corn	1.00	Standard	25
Wheat	0.84	0.17	5
Grain sorghum	0.99	0.10	6
Soybeans	1.22	0.22	5
Pasture	0.86	0.09	10
Alfalfa	0.87	0.14	8

TABLE 10. DESIGN FACTOR D FOR RATIO OF DISPOSAL AREA TO FEEDLOT AREA

Ratio	D	Std. dev.	No. of runs
1.0	1.25	0.30	10
2.0	1.00	Standard	22
3.0	0.82	0.09	10
4.0	0.79	0.12	10

TABLE 11. DESIGN FACTOR R FOR DISPOSAL RATE PER DAY OVER DISPOSAL AREA

Disposal rate, in/day	R	Std. dev.	No. of runs
0.5	1.00	Standard	23
1.0	0.88	0.13	10
1.5	0.82	0.18	10
2.0	0.79	0.20	10

TABLE 12. DESIGN FACTOR H FOR MAXIMUM DEPTH OF RETENTION POND

Max. depth, ft	H	Std. dev.	No. of runs
4	1.24	0.22	5
6	1.08	0.13	5
9	1.00	Standard	13

TABLE 13. DESIGN FACTOR M FOR IRRIGATION MANAGEMENT

Percent available soil moisture (PAVLU)*	M	Std. dev.	No. of runs
90	1.00	Standard	28
50	1.98**	0.86	9

*PAVLU is the percentage of available moisture in the upper zone below which irrigation occurs if other management conditions are met.

**For locations with moisture deficits less than 10 in. the 50 percent rate should be used cautiously. The probability of having enough days per year to dispose of all runoff decreases rapidly.

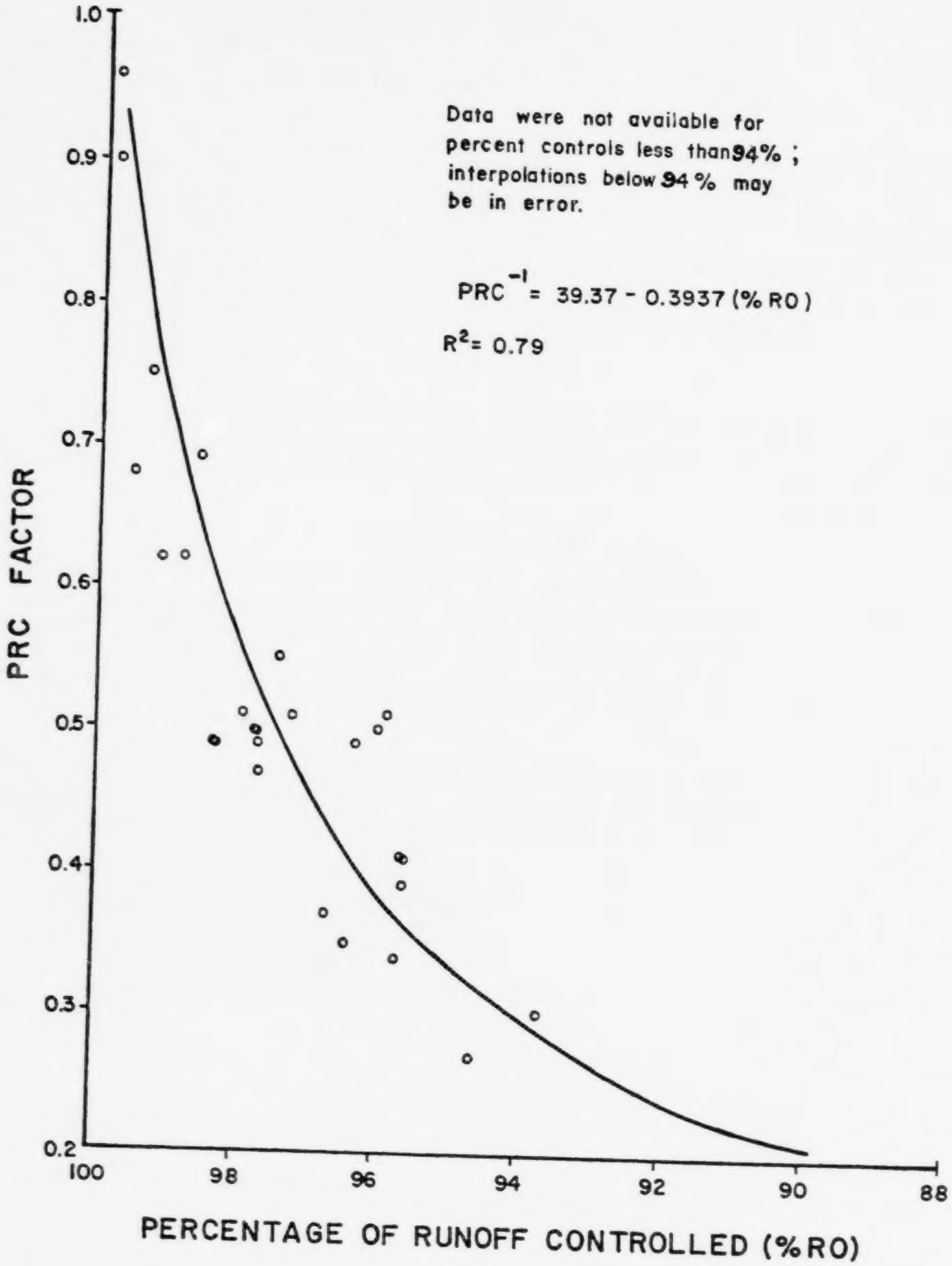

Figure 8. Graphical determination of the PRC design factor.

TABLE 14. DESIGN FACTOR PRC FOR PERCENTAGE OF FEEDLOT RUNOFF CONTROLLED

Percent controlled	PRC
100	1.0
99	0.70
98	0.55
97	0.45
96	0.40
95	0.35
94	0.30

To determine required surface area for a retention pond that serves exclusively as an evaporation pond, one reads from Figure 7 the SURF value for the PREVAP of the particular location of the feedlot and multiply the value of that surface area by SR.

$$EPSA = SURF \times SR \tag{29}$$

in which EPSA = evaporation pond surface area required for 100 percent control: (SR and SURF were previously defined.) If the pond depth is greater than 6 feet the EPSA value should be maintained, which results in a larger storage volume than required under standard conditions. If the depth is less than 6 feet, EPSA should be increased to provide a storage volume equivalent to that for the 6 ft. standard EPSA.

The effects of variables on evaporation pond sizing were not evaluated because few variables could be changed. The consequences of a discharge from an evaporation pond seem to preclude a design that would not provide 100 percent control.

EXAMPLES

The following examples will illustrate use of the procedure:

Runoff Control with Irrigation Disposal

A 60-ac feedlot operation at Topeka, Kansas.
Crop: Alfalfa
Disposal area: 120 ac
Disposal rate: 1.5 in./day over entire disposal area on an irrigation day
Maximum retention pond depth: 6.00 ft
Disposal management: Dispose anytime available moisture less than 90 percent of field capacity
Control capable of a) 100 percent, and b) 98 percent

Soil type: 7 (silt loam)
Annual precipitation: 37 in.
Mean annual lake evaporation: 48 in.
Moisture deficit (MD): 11 in.
PONVOL from Fig. 6: 600 ac-in.

$SR = 1.50$
$S = 0.99$
$C = 0.87$
$D = 1.00$
$R = 0.82$
$H = 1.08$
$M = 1.00$
$PRC = 1.00_a \text{ and } 0.55_b$

Thus,

$$RPV = (600)(1.50)(0.99)(0.87)(1.00)(0.82)(1.08)(1.00)(1.00)_a = 686 \text{ ac-in. (for 100\% control)}$$

$$RPV = 686(0.55)_b = 378 \text{ ac-in. (for 98\% control)}$$

Runoff Control by Evaporation

An 80-ac feedlot operation at Oklahoma City, Oklahoma.
Annual precipitation: 31 in.
Mean annual lake evaporation = 60 in.
PREVAP = 31/60
SURF from Fig. 7 = 16.5 ac
SR = 2.0.
Pond depth = 6 ft.

Substituting into Eq. 29,

$$EPSA = 2.0 \times 16.5 = 33.0 \text{ ac}$$

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APPENDIX A

FROMKSU USER'S MANUAL

FROMKSU is a continuous simulation digital computer program written in "Ten Statement" Fortran for simplicity and compatibility with most machines having Fortran capability. The model uses historical daily precipitations and temperatures to evaluate the design of a particular feedlot at a particular location. This version of FROMKSU reads the required precipitation and temperature data from tapes provided by the National Weather Service Climatic Center in Asheville, North Carolina. A magnetic tape drive is required in order to use this program. Minor alterations would be necessary in order to read this data from other sources. A printout of the computer program is in Appendix B.

INPUT REQUIREMENTS

The required inputs to the model are listed in Table A-1.

TABLE A-1. LIST OF INPUT DATA

Class	Variable name	Input method	Definition
I.	Climatological variables; either from magnetic tape or mean-monthly values read from cards for use in Penman Eq. (NAMELIST variables initialize the tape).		
	INDST	NAMELIST/BETA/	Weather station identifier
	YSTART	NAMELIST/BETA/	Beginning year of simulation
	MSTART	NAMELIST/BETA/	Beginning month of simulation
	YEND	NAMELIST/BETA/	Ending year of simulation
	TMAX(ND*)	Format (Magnetic tape)	Maximum daily temperature (°F)
	TMIN(ND)	Format (Magnetic tape)	Minimum daily temperature (°F)
	PREC(ND)	Format (Magnetic tape)	Daily precipitation (inches)
	RHD(12)	Format (Card)	Mean monthly relative humidity (%)
	PSUNS(12)	Format (Card)	Mean monthly percent sunshine (%)
	WIND(12)	Format (Card)	Mean monthly wind speed (miles/hour)
	RA(12)	Format (Card)	Mid-monthly intensity of solar radiation (in mm of H_2O evaporated/day)
II.	Other variables used in Penman Eq.		
	RCROP	NAMELIST/ALPHA	Reflectance coef. (albedo) of crop as ratio (usually 0.23)

(continued)

TABLE A-1 (continued)

BRUNTA	NAMELIST/ALPHA	Coefficient, c, for Brunt relation in Penman Eq. 15 (Fig. 3)
BRUNTB	NAMELIST/ALPHA	Coefficient, d, for Brunt relation in Penman Eq. 15 (Fig. 3)
E	NAMELIST/ALPHA	Wind coefficient, e, in Penman Eq. when calculating potential ET. (Usually 0.75)
EPRIM	NAMELIST/ALPHA	Wind coefficient, e, in Penman Eq. when calculating lake evaporation (usually 0.50)
III. Variables relating to the feedlot.		
LTAREA	NAMELIST/BETA/	Feedlot area (acres)
GROW	NAMELIST/ALPHA/	Precipitation routed through SCS Eq. from Nov. thru Mar. (inches; usually 1.25)
DORM	NAMELIST/ALPHA/	Precipitation routed through SCS Eq. from April thru Oct. (inches; usually 1.00)
IV. Variables relating to the retention pond.		
L	NAMELIST/BETA/	Base length of retention pond (feet)
W	NAMELIST/BETA/	Base width of retention pond (feet)
S	NAMELIST/BETA/	Pond side-slope as a ratio of run/rise
HMAX	NAMELIST/BETA/	Maximum working depth of pond (feet)
PCVMAX	NAMELIST/ALPHA/	Level of pond below which irrigation not allowed, expressed as a ratio of max. volume (usually 0.05)
V. Variables relating to the disposal area		
DSAREA	NAMELIST/BETA/	Disposal area size (acres)
DSRATE	NAMELIST/BETA/	Irrigation disposal rate (inches/day)
CROP	NAMELIST/ALPHA/	Cover crop on disposal area
SOIL	NAMELIST/ALPHA/	Soil type in disposal area
PAVLU	NAMELIST/ALPHA/	Percentage (as a ratio) of available soil moisture in upper zone below which irrigation allowed (usually 0.9, 0.5 or 0.0)
DGSB	NAMELIST/ALPHA/	Date of the month the crop is planted (integer)
MGSB	NAMELIST/ALPHA/	Month crop is planted (integer)
DGSE	NAMELIST/ALPHA/	Date of month crop is harvested (integer)
MGSE	NAMELIST/ALPHA/	Month crop is harvested (integer)
MMAT(12)	Format (Card)	Mean monthly temperature (°F)

*ND = number of days in month (28-31).

INST, YSTART, MSTART, and YEND in Class I of Table A-1 locate appropriate block of precipitation and temperature data on the magnetic tape. The program automatically adjusts for data which is noted as "missing" (999 values) on the tape by assuming the previous day's value. The data should always be spot checked for unreasonable or blank values. The data is provided on 9-track "Daily Observation" tapes in NWS FORMAT II.* The other variables in this class refer to development of the Penman Eq. 15 in the text.

The 12 monthly values of RHD, PSUNS, WIND, and MMAT (for subroutine CROPCO) are obtained from published records (1). If the location of the feedlot does not correspond to the location of a first-order station in (1), it is necessary to interpolate values from surrounding first-order stations. This is not difficult except where first-order stations are sparse and/or the climate is highly variable over short distances. The data is input by standard format. The arrangement of this data on cards is shown by example in a later section. The variable WIND for Z=2 meters is converted to WVD at 30 ft. internally. The class II variables for use in Eq. 15 have been defined in the text and should be self explanatory.

The remaining input variables involve physical parameters of the feedlot, storage pond, and disposal area, respectively. The feedlot requires the specification of area, LTAREA, and to the variables GROW and DORM, which have been evaluated as 1.25 inches and 1.00 inches, respectively as discussed in the text.

The Class IV variables specify the storage pond dimensions. The pond is a prismatoid (Fig. 4) in which the base length, width, side slope, and maximum working height must be specified. The user should be cognizant of both the land forms and the general practice in a given area in establishing these shape variables.

The disposal area requires many inputs, which include physical parameters, runoff curve numbers (3), crop types and transpiration coefficients, soil types and soil moisture parameters, and disposal rates and disposal criteria. DSAREA is self-explanatory. CROP is an integer number designating the crop on the disposal area: 1 = WHEAT; 2 = GRAIN SORGHUM; 3 = CORN; 4 = SOYBEANS; 5 = PASTURE; 6 = ALFALFA; 7 = FALLOW. Each of these crops has a consumptive use coefficient, KCROP(7,12), for each month of the year. The coefficients are determined internally by subroutine CROPCO. Subroutine CROPCO calculates the monthly crop growth coefficients, k in Eq. 18, for use in the main program. The coefficients applied to the potential evapotranspiration (PET), predict the actual evapotranspiration (AET). These coefficients reflect stage of crop growth, length of growing season, and mean monthly average temperatures.

Coefficients used for early testing of the model were obtained from the 1962 Kansas Irrigation Guide (5). Since initial testing of the model was limited to Kansas stations, these monthly coefficients were read into the computer from data cards. When testing began on stations outside of Kansas, it was necessary to calculate a set of coefficients for each individual station. These calculations were time consuming and required data from crop growth curves. To simplify this, CROPCO was developed which requires a minimal amount of input by the user. These coefficients were determined by procedures outlined in SCS, Technical Release No. 21 (4).

---

*For details write National Climatic Center, Federal Bldg., Asheville, NC 28801

Inputs to the subroutine are mean monthly average temperatures (MMAT), type of crop (CROP), months (MGSB, MGSE) and days (DGSB, DGSE) when growing season begins and ends. Table A-2 shows a sample consumptive use calculation from TR 21 for corn at Raleigh, North Carolina. CROPCO calculates crop growth coefficients in a similar fashion. Column 10 in Table A-2 is a list of the consumptive use coefficients k for months in the growing season. The coefficients k are the KCROP (7, 12) monthly crop growth coefficients in subroutine CROPCO. The major difference in the procedure in TR 21 and subroutine CROPCO is that continuous equations have been developed for crop growth stage curves in TR 21 which allow computation by the computer.

Approximately 20 points were read from each crop growth stage curve for winter wheat, sorghum, corn and soybeans. These data were analyzed by a statistical program which produced best fit equations to the data. In all cases statistical analysis had clearly shown these equations fit the curves quite well. Third or fourth order polynomial equations with R^2 exceeding 0.97 were used. For perennial crops such as pasture and alfalfa the coefficients are best given for each individual month. The inputs which the user must provide for CROPCO are shown in Table A-1, Class V; namely, CROP, DGSB, MGSB, DGSE, MGSE and MMAT (12).

Figure A-1 is the general algorithm of subroutine CROPCO. A shifting process incorporated into the procedure allows the computer to use normal looping procedures for crops whose MGSB is greater than its MGSE such as in winter wheat. A limitation of this program which the user should be aware of is that in the event the growing season exceeds one year this routine has no way of detecting this and erroneous results will be obtained.

Since the main program applies the monthly crop coefficient to the entire month, the coefficient in the beginning and ending month have been prorated to allow for this. For example, assume a monthly coefficient of 0.30 is calculated for the planting month where the beginning data is the 20th of the month. Since one-third of a month is used for growth, the 0.30 coefficient is adjusted to 0.10. The 0.10 coefficient is then applied to the entire month to achieve essentially the same results.

Testing the program for accuracy was accomplished by inputing the data in the Table A-2 example into subroutine CROPCO. Table A-3 compares results. Note the adjustment made in the beginning and ending month.

The curve generated by CROPCO for corn is compared to the TR 21 curve in Figure A-2. Although these curves are for corn, they are typical of the closeness of curves for the other crops.

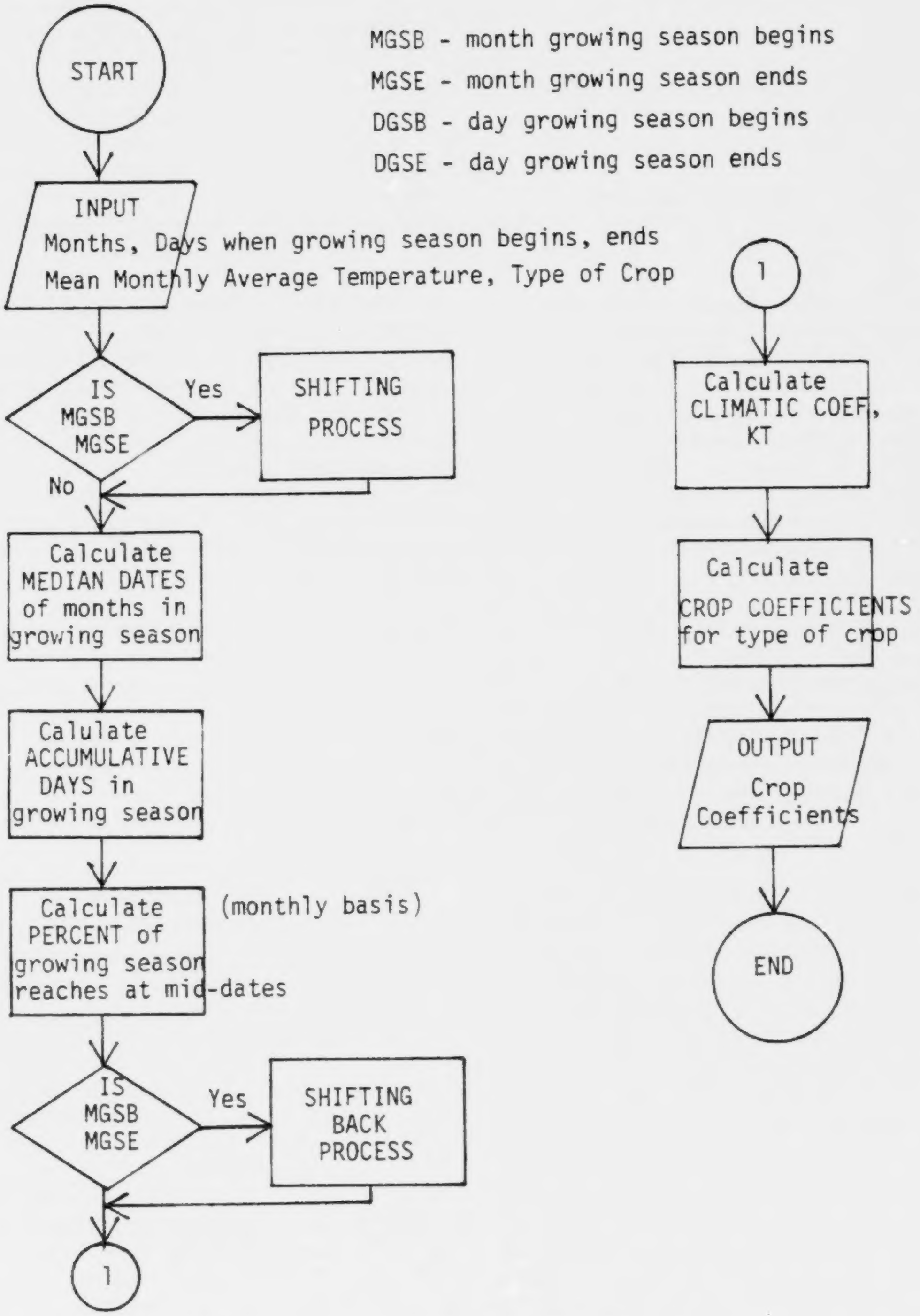
The crop reflection coefficient (RCROP) can be specified by the user. According to Gray (6), the albedo of green crops varies from 0.20 to 0.25, so 0.23 is a suggested representative value.

TABLE A-2. SAMPLE CALCULATION NO. 1--ESTIMATE OF AVERAGE DAILY, MONTHLY AND SEASONAL CONSUMPTIVE-USE BY CORN AT RALEIGH, NORTH CAROLINA (HARVESTED FOR GRAIN)

Lat. 35° 47' North

(1) Month or period	(2) Midpoint of period	(3) Accum. days to midpoint	(4) Percent of growing season	(5) Mean air temp. °F.	(6) Daylight hours p. percent	(7) Cons. use factor f.	(8) Climate coeff. k_t	(9) Growth stage coefficient k_c	(10) Cons. use coefficient k	(11) Monthly cons. use u. inches	(12) Daily cons. use u. in./day
Apr. 20											
	Apr. 25	5	4.2	63.5	3.05	1.94	.79	.46	.36	.70	.070
May											
	May 15	25	20.8	69.2	9.79	6.77	.88	.59	.52	3.52	.114
June											
	June 15	56	46.7	76.9	9.81	7.54	1.02	1.02	1.04	7.84	.261
July											
	July 15	86	71.7	79.4	9.98	7.92	1.06	1.05	1.11	8.79	.284
Aug.											
	Aug. 9	111	92.5	78.3	5.52	4.32	1.04	.91	.95	4.10	.228
Aug. 18											
Season Totals						28.49			.88	24.95	

*p. 20, IRRIGATION WATER TECHNICAL RELEASE NO. 21, USDA, SCS, 1967



MGSB - month growing season begins
MGSE - month growing season ends
DGSB - day growing season begins
DGSE - day growing season ends
START
INPUT
Months, Days when growing season begins, ends
Mean Monthly Average Temperature, Type of Crop
IS MGSB MGSE
Yes
SHIFTING PROCESS
No
Calculate MEDIAN DATES of months in growing season
Calulate ACCUMULATIVE DAYS in growing season
Calculate PERCENT of growing season reaches at mid-dates
(monthly basis)
IS MGSB MGSE
Yes
SHIFTING BACK PROCESS
1
1
Calculate CLIMATIC COEF, KT
Calculate CROP COEFFICIENTS for type of crop
OUTPUT
Crop Coefficients
END

Figure A-1. Subroutine CROPCO flowchart.

TABLE A-3. COMPARISON OF k COEFFICIENTS

Midpoint of Period	k from Table A-2	k from CROPCO
A (Planting April 20)	.36	0.13
M	.52	0.53
J	1.04	1.01
J	1.11	1.13
A (Harvest Aug. 18)	.95	0.55

SOIL is an integer number representing soil type. There are 12 general irrigation design class soils as listed in Tables 3 and 5 as selected from reference (5). The user is required to select the class which best represents the soils in the area. In doing so, the user is then specifying the runoff curve numbers and the soil moisture characteristics which are internally programmed into the model. The soil moisture parameters for each soil class are listed in Table 3. They are specified using DATA statements. Each soil class has an upper and lower zone available water (AVLFCV, AVLFCL), field capacity (FCU, FCL), permanent wilting point (PWPUZ, PWPLZ), and a soil moisture at saturation (SMSATU, SMSSATL), respectively. All values are input in inches.

The disposal rate (DSRATE) is an arbitrary number which governs the rate at which the wastewater in the storage pond is pumped out. Rates of 0.5, 1.0, 1.5 and 2.0 inches per day over the disposal area are used, although 0.5 inches per day was used as the standard. Pump sizes and rate of application per day to the field are also important considerations in setting DSRATE. These rates should not cause direct surface runoff unless precipitation occurs on an irrigation day. The volume of water pumped out per day is DSRATE x DSAREA. STORM is the design storm P25 for the location obtained from published data (7).

PAVLU initiates an irrigation scheme. PAVLU can vary from zero, which evaluates a "non disposal" or pure evaporation scheme, to one which represents a scheme in which disposal can occur (other disposal criteria being positive) whenever the soil moisture falls below field capacity. Normally three conditions are tested: 1) PAVLU = 0.90, intensive irrigation; 2) PAVLU = 0.50, normal irrigation; 3) PAVLU = 0.0, evaporation. When PAVLU = 0, natural moisture accounting continues in the disposal area. The accounting can be used to adjust the natural moisture budget to expected values for the location being tested, and to determine if irrigation is producing excessive additional runoff.

E is the coefficient e in the mass transfer part of the Penman Equation This is the only other coefficient besides BRUNTA and BRUNTB which should be adjusted by the user in the Penman equation. It should have a value ranging from 0.5 to 1.0, depending upon average wind velocities. This factor can be used to adjust the lake evaporation to the published value for a location (2) or (8).

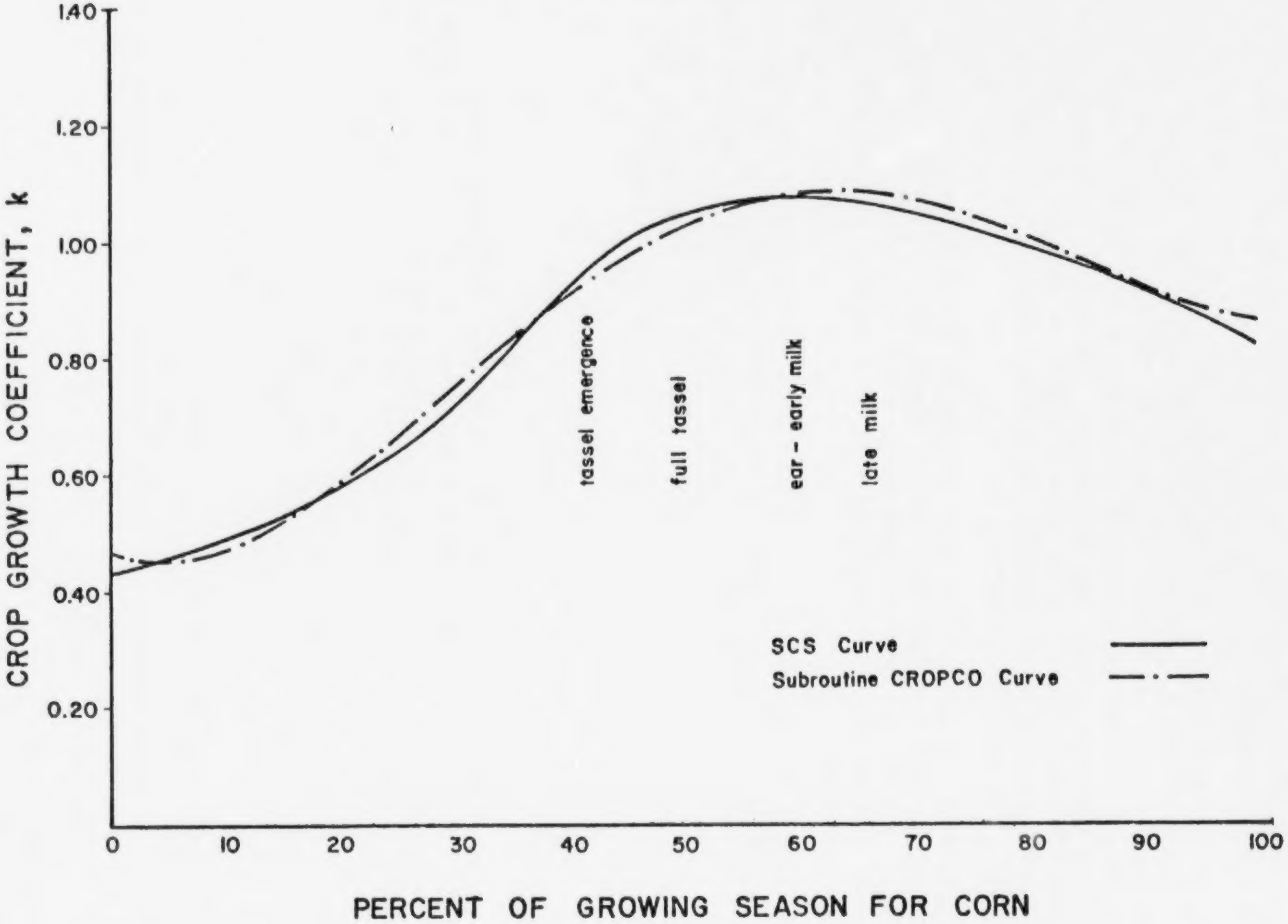


Figure A-2. Comparison of crop growth stage coefficient curves for corn.

EXAMPLE

A typical 25-year simulation for Belleville, Kansas, is included here for discussion and demonstration.

Figure A-3 is a display of all card images in proper order for all data which is input either by NAMELIST or by formatted READ statements. The NAMELIST statement is convenient for variables which are changed regularly from run to run. Since the variables are named in the NAMELIST, the ordering of variables within the list can be changed. The statement, however, must begin with the NAMELIST identifier (i.e., &ALPHA or &BETA) and end with &END. If a compiler does not have NAMELIST capability, these variables would best be input using formatted READ statements.

All formatted data must be input exactly as shown on the cards, except for card no. 1. The city and state is an alphanumeric field of 20 spaces beginning in column 21. Any combination of letters, numbers, symbols, or blanks can be used in fields 21 through 40. The program ignores the remaining fields on this card.

The meteorological data is on card nos. 6-17. Each card represents a month, beginning with January, and contains PSUNS(12), RHD(12), RA(12), WIND(12), and MMAT(12) in sequence for the month according to FORMAT(2X,F2.2, F2.0, F4.2, F3.1, F3.1). The number of the month that a particular card represents is printed in the 2X skipped columns at the beginning of each card. The remaining card nos. 18-20 are IBM control cards that identify the climatic data on magnetic tape.

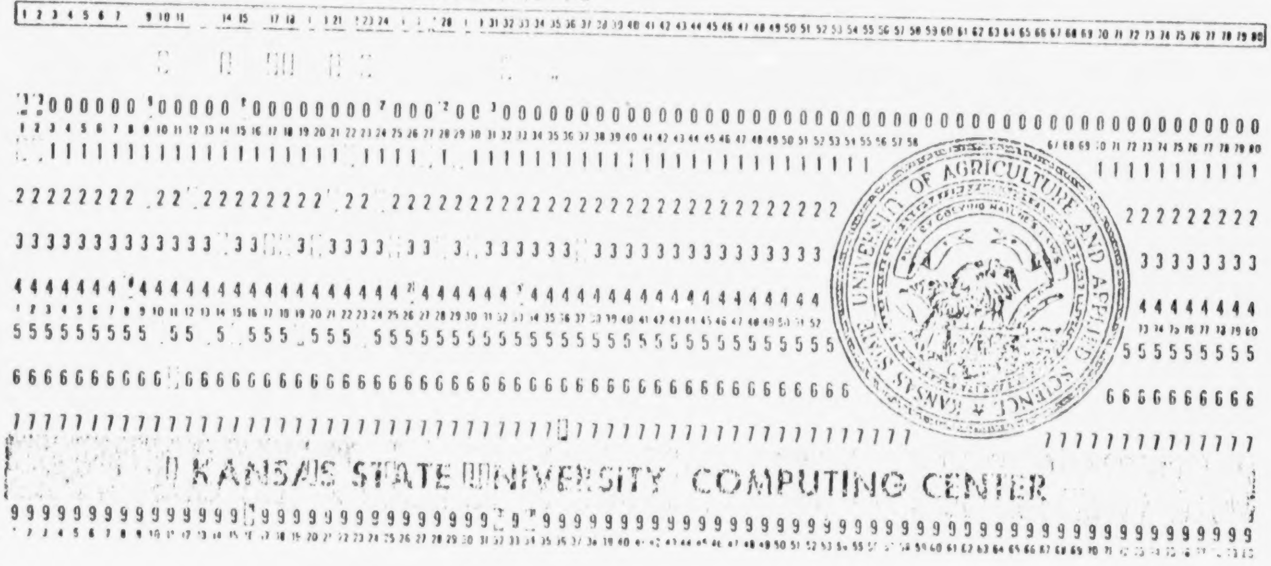
OUTPUT ANALYSIS

Appendix B includes a printout of results for the 25-year standard run at Belleville, Kansas, for both irrigation and evaporation. The first page of output is a summary of input parameters. The simulation is for the years 1949-1973. The P25 event is 5.10 inches (CRITICAL EVENT), the feedlot area is 40 acres, and the disposal area is 80 acres with a corn as the irrigated crop. The pond dimensions give a maximum pond volume of 202.33 acre-inches, which is 57 percent of the 100 percent size as reported in the main text. The purpose of using the small volume is to demonstrate the type of output generated when there is less than 100 percent control.

The irrigation management (PAVLU) scheme is intensive. Irrigation will occur whenever all other disposal criteria are met and the upper zone available soil moisture is less than 0.90 of field capacity. The rate of application is 0.50 inches per day over the disposal area, which is equivalent to a disposal volume of 40 acre-inches/day.

The annual summary for 1949 on the following page is a three-level summary of the water budget for the year. The first level is a summary of the storage facility budget. Inflows are precipitation over a 3.14 acre receiving area (stated as equivalent precipitation over an 80-acre disposal area) and

```
Card No.
   1                         BELLEVILLE, KANSAS  -          140682
   2  r &ALPHA CROP=3,DORM=1.0,GROW=1.25,PAVLU=0.9,SOIL=5,RCROP=0.23,E=0.75,EFRIM=0.5,
   3  r BRUNTA=0.62,BRUNTB=0.039,PCVMAX=0.05,DGSB=1,DGSE=25,MGSB=5,MGSE=10,&END
   4  ' &BETA LTAREA=40.0,DSAREA= 80.0,L=570.0,W=190.0,S=3.0,YSTART=1949,YEND=1973,
   5  r MSTART=1,HMAX= 9.0,INDST=0682,STORM=5.1,DSRATE=0.5,&END
   6  ' 16078 611 77281                                              BELLEVILLE, KANS.
   7  r 26078 840 81329                                             BELLEVILLE, KANS.
   8  r 363771107 95416                                             BELLEVILLE, KANS.
   9  . 463771394 98540                                             BELLEVILLE, KANS.
  10  ' 565771590 86632                                             BELLEVILLE, KANS.
  11  ' 672791669 80739                                             BELLEVILLE, KANS.
  12  ' 779761630 71800                                             BELLEVILLE, KANS.
  13  ' 876791482 69785                                             BELLEVILLE, KANS.
  14  r 972781226 77695                                             BELLEVILLE, KANS.
  15  '107078 939 76577                                             BELLEVILLE, KANS.
  16  '116478 680 78421                                             BELLEVILLE, KANS.
  17  '125879 560 75318                                             BELLEVILLE, KANS.
  18  //GO.FT01F001 DD UNIT=TAPE9,VOL=SER=995401,LABEL=(15,SL,,IN), BELLEVILLE, KANS.
  19  //     DISP=SHR,DCB=(DEN=2,LRECL=320,BLKSIZE=320,RECFM=FB),
  20  //      DSN=BELVILLE.KANS.DATA.YR49-73
```



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best available copy.

Figure A-3. Card images in input deck for FROMKSU.

feedlot runoff, while outflows include disposal volume, surface evaporation and overflow discharge. The last column is the change in the volume of runoff stored in the facility over the month or year. Since all values are in inches over the disposal area of 80 acres, the actual annual precipitation input on the pond receiving area is 1.26 inches x 80/3.14 = 32.0 inches, which corresponds to the published total precipitation at Belleville, in 1949. The annual balance indicates that all moisture has been accounted for, since 1.26 + 5.63 - 5.96 - 0.90 = 0.03.

The second level is the moisture budget on the disposal area. The irrigation input should match the storage pond disposal volume. The outputs are interception (which is really an evapotranspiration loss), surface runoff (runoff curve numbers applied to precipitation plus irrigation), percolation, which is the quantity of water dropping out below the root zone, and actual evapotranspiration (AET). The CHANGE IN SM is the change in total soil moisture for the month or year. In this case INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE = CHANGE IN SM.

Snow is generally a small factor in Kansas. The amount of moisture in the snow pack is monitored for the season. The amount in storage at the end of the year and the change in storage during the year are printed below the monthly accounting. If there is an increase in snow storage, the total increase should be deducted from the precipitation for the year as that amount did not enter into the budget. Similarly a decrease in snow storage should be added to precipitation when previously stored snow entered the budget during the year. In this case: 32.02 + 5.96 -7.62 - 3.82 - 27.29 - 0.08 = -0.83.

The operating characteristics for the year are tabulated below the monthly accounts. There were no disposal pond overflows (DISCHARGE = 0.0) so the percent of wastewater controlled is 100.00. There were 151 potential disposal days, but disposal water was available on only 17 days.

The percent of pond volume required is 51.80 in 1949. In 1951, 58, 61, 62, 71, and 73 the pond discharged by overflow. The date and volume of each discharge is tabulated at the top of the annual summary sheet for each year that discharge occurs. In 1958 and 61 the critical event, P25, was exceeded at Belleville. The data and magnitude of these events are also recorded above the annual summary. In both cases a pond discharge occurs on the same date. It should be noted, however, that the total runoff control with this small pond is approximately 98 percent, and that the P25 volume (204 ac-in.) is nearly equal to actual pond volume of 202.33 ac-in. This concurs with the general conclusion that the P25 volume results in roughly 98 percent volume control.

Following the annual summary for the last year in the simulation, a run summary is printed. This summary includes a repeat of the input table and other meteorological, pond operation, and disposal area averages needed for interpretation. These are self explanatory.

The evaporation run output follows the irrigation output. The input data is identical to the previously discussed irrigation example, except that the irrigation management, PAVLU, is 0.0. The pond volume is much larger than that required when irrigation disposal is utilized. This run resulted in 100 percent control, so that the pond is slightly too large. In 1973, 99.39 percent of the pond volume was utilized, so that the direct receiving area for precipitation (47.92 acres) was used as the surface area required for 100 percent control by evaporation.

REFERENCES (APPENDIX A)

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APPENDIX B

1. FROMKSU Source Code.
2. Example of 25-year simulation of irrigation disposal at Belleville, Kansas.
3. Example of 25-year simulation of evaporation disposal at Belleville, Kansas.

```
//RCL03790 JOB (XXXXX,XXXXXXXX,,3,,1602),'ZOVNE',TIME=(,45)             JOB 199
***TAPE9
//RUN    EXEC FORTGCLG
//FORT.SYSIN DD *

KSU003I REGION SIZE -  256K, MAXIMUM CORE USED -  142K,  TIME =  18.58.00
KSU004I EXCP CCUNT - UR 347      968,  UR 381       0,  DA 252       10,  UR 301     859
KSU001I STEP   1 FORT      EXECUTION TIME =           17.32 SEC    RETURN CODE =     0


KSU003I REGION SIZE -  256K, MAXIMUM CORE USED -  158K,  TIME =  18.58.18
KSU004I EXCP COUNT - DA 250       85,  DA 253       0,  DA 254       0,  DA 252      26,  DA 251      20,  UR 347      46
KSU004I EXCP COUNT - DA 252       11,      DUMMY
KSU001I STEP   2 LKED      EXECUTION TIME =            1.00 SEC    RETURN CODE =     0

//GO.SYSIN DD *
//GO.FT01F001 DD UNIT=TAPE9,VOL=SER=995401,LABEL=(15,SL,,IN),
//     DISP=SHR,DCB=(DEN=2,LRECL=320,BLKSIZE=320,RECFM=FB),
//      DSN=BELVILLE.KANS.DATA.YR49-73

KSU003I REGION SIZE -  256K, MAXIMUM CORE USED -   54K,  TIME =  19.04.13
KSU004I EXCP COUNT - DA 252        0,  UR 308      18,  UR 347   1,283,  UR 381       0,  DA 252       0,  DA 251       0
KSU004I EXCP COUNT - UR 346        0,  TA 182      301
KSU001I STEP   3 GO        EXECUTION TIME =           24.15 SEC    RETURN CODE =     0


KSU002I JOB RCL03790 EXECUTION TIME =            42.47 SEC




 HASP-II V3.1 JOB STATISTICS --    883 CARDS READ --    2,334 LINES PRINTED --      0 CARDS PUNCHED --   COPY   1 OF   1
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C     FROM KSU - FEEDLOT RUNOFF MODEL     KANSAS STATE UNIVERSITY -
C    JOINTLY PROGRAMMED BY THE CIVIL AND AGRICULTURAL ENGG. DEPT.
C                KANSAS STATE UNIVERSITY
C                         1977
C
      INTEGER CROP,DAY,FROZE,SOIL,STIND,T,YEAR,YEARS,YEND,YSTART
      REAL IRRVOL,IRRSUM
      INTEGER DGSB,DGSE,PREVYR
      REAL IA,IAADD,IAET,KCROP,KS,LAKEVP,LKEVPT,LTAREA,L,M,MA
      REAL MAXVOL,MMAT(12),MR
      DIMENSION AMONTH(13),AVLFCL(12),AVLFCU(12),C(12),FCL(12),FCU(12)
      DIMENSION CNS1(7),CNS3(7),CNS5(7),CNS12(7)
      DIMENSION KCROP(7,12),NDIM(12),PUACCT(13,8),PREC(31),PSUNS(12)
      DIMENSION PWPLZ(12),PWPUZ(12),RA(12),RCM(12,7),RCN(12,7),RHO(12)
      DIMENSION SMACCT(13,8),SMSATL(12),SMSATU(12),TAVG(31),TMAX(31)
      DIMENSION TMIN(31),U(12),WIND(12)
      COMPLEX*16 KROP*16(7)/'WHEAT','SORGHUM','CORN','SOY BEANS',
     1      'PASTURE','ALFALFA','FALLOW'/
      DATA AMONTH/'JAN.','FEB.','MAR.','APR.','MAY ','JUNE','JULY',
     1      'AUG.','SEPT','OCT.','NOV.','DEC.','TOT.'/
      DATA AVLFCU/2.6,1.5,2.5,2.4,2.5,2.6,2.4,2.4,2.4,2.2,1.5,1.0/
      DATA AVLFCL/2.7,2.9,5.7,2.5,6.7,4.2,6.6,3.3,5.2,4.1,4.1,2.5/
      DATA C/0.2,0.2,0.177,0.177,0.177,0.177,0.159,0.159,0.138,0.138,
     1      0.134,0.131/
      DATA CNS1/84.0,86.0,86.0,86.0,80.0,83.0,84.0/
      DATA CNS3/91.0,82.0,82.0,82.0,74.0,76.0,78.0/
      DATA CNS5/73.0,75.0,75.0,75.0,61.0,69.0,65.0/
      DATA CNS12/61.0,65.0,65.0,65.0,39.0,55.0,61.0/
      DATA FCU/4.6,4.4,4.5,4.6,4.5,4.3,4.0,4.0,3.8,3.5,2.3,1.7/
      DATA FCL/9.4,9.4,14.2,7.0,13.9,9.1,13.7,6.8,9.2,7.0,7.0,4.3/
      DATA NDIM/31,28,31,30,31,30,31,31,30,31,30,31/
      DATA PWPUZ/2.0,2.9,2.0,2.2,2.0,1.7,1.6,1.6,1.4,1.3,0.8,0.7/
      DATA PWPLZ/6.7,6.5,8.5,4.5,7.2,4.9,7.1,3.5,4.0,2.9,2.9,1.8/
      DATA SMSATU/5.8,6.2,5.7,5.7,5.7,5.5,5.4,5.4,5.3,5.2,4.8,4.8/
      DATA SMSATL/11.8,11.5,16.3,8.2,15.8,10.4,15.4,7.7,13.9,13.2,13.2,
     1      12.9/
      DATA U/0.47,0.47,0.39,0.39,0.39,0.39,0.35,0.35,0.31,0.31,0.28,
     1      0.24/
      DATA AET,AETLZ,AETUZ,B2,DISVOL,DPERC,EU,EXCESS,IA,IAADD,IAET,M,MA,
     1      MR,PACK,PACKPY,POVOL,PERC,PONVOL,P1,P2,P3,SNOMLT,TOPERC,TIME,
     2      TPEVAP,TRNGF,T1,T2,EVPSMR/30*0.0/
      DATA CROP,DAY,IDAY,IYRC,MM,PREVYR,SOIL,T/8*0/
      DATA PDT,SMLZ,SMMAXL,SMUZ/37.5,9.35,2.2,3.25/
      DATA DRY,PEAK,PREVOS,TPREC,WET/5*0.0/
      DATA AVAILL,AVAILU,CM,DSCVOL,DSDAYS,DSPERC,DSRAFF,EVAPLK,H,IRRSUM,
     1      SNOW,WASTWW/12*0.0/
      NAMELIST/ALPHA/BRUNTA,BRUNTB,CROP,DGSB,DGSE,DORM,E,GROW,MGSB,
     *MGSE,PAVLU,PCVMAX,KCROP,SOIL,EPRIM
      NAMELIST/BETA/DSAREA,DSRATE,HMAX,INDST,L,LTAREA,MSTART,S,STORM,W,
     *YEND,YSTART
C
C          ***** INPUTS *****
C
C
      READ(5,20) NAME,OF,CITY,AND,STATE
   20 FORMAT(20X,5A4)
C***  READ THE LOT,POND AND DISPOSAL PARAMETERS
      READ(5,ALPHA)
      READ(5,BETA)
C***  READ THE MONTHLY AVERAGE METECROLOGICAL DATA
      READ(5,60) (PSUNS(I),RHO(I),RA(I),WIND(I),MMAT(I),I=1,12)
   60 FORMAT(2X,F2.2,F2.0,F4.2,F3.1,F3.1)
      DO 80 K=1,7
      RCN(1,K)=CNS1(K)
      RCN(2,K)=CNS1(K)
      RCN(3,K)=CNS3(K)
      RCN(4,K)=CNS3(K)
      RCN(5,K)=CNS5(K)
      RCN(6,K)=CNS5(K)
      RCN(7,K)=CNS5(K)
      RCN(8,K)=CNS5(K)
      RCN(9,K)=CNS5(K)
      RCN(10,K)=CNS5(K)
      RCN(11,K)=CNS5(K)
   80 RCN(12,K)=CNS12(K)
      CALL CROPCO(CROP,MGSB,DGSB,MGSE,DGSE,KCROP,NDIM,MMAT)
C
C***  A1,A2,A3,A4,AND A5 ARE COEFFICIENTS USED IN VOLUME ROUTINE
      A1=L*W
      A2=S*(L+W)
      A3=4./3.*S**2
      A4=2.*A2
      A5=4.*S**2
C***  VOLMAX IS THE MAXIMUM VOLUME HELD BY THE STORAGE FACILITY
      VOLMAX=(A1*HMAX+A2*HMAX**2+A3*HMAX**3)/3630.
C***  PSAREA IS THE DIRECT RECEIVING AREA OF THE FACILITY
      PSAREA=((W+2.*S*HMAX)*(L+2.*S*HMAX))/43560.
      SMPD=SMLZ+SMUZ
      YEARS=YEND-YSTART+1
      WRITE(6,100)NAME,OF,CITY,AND,STATE,YSTART,YEND,STORM,LTAREA,L,W,S,
     *HMAX,VOLMAX,PSAREA,DSAREA,KROP(CROP),SOIL,DSRATE,PAVLU
  100 FORMAT('1',10X///////////10X,'STATION:',3X,5A4,10X,I4,'  TO  ',I4,
     1////10X,'CRITICAL EVENT- ',F4.2,' INCHES'////10X,'FEEDLOT AREA-',F
     26.2,' ACRES'////10X,'POND VARIABLES:'//25X,'(A) BASE DIMENSION--',
     3F7.2,'  FEET BY ',F7.2,'  FEET'//25X,'(B) SIDE SLCPE--   RUN: RISE
     4 = ',F3.1,' : 1'//25X,'(C) MAXIMUM DEPTH--  ',F5.2,'  FEET'//25X,
     5'(D) MAXIMUM POND VOLUME--  ',F9.2,' ACRE-INCHES'//25X,'(E) DIRECT
     6 RECEIVING AREA (FOR PRECIPITATION) --  ',F8.2,' ACRES'////10X,
     7'DISPCSAL AREA VARIABLES:'//25X,'(A) DISPOSAL AREA--   ',F6.2,
     8'  ACRES'//25X,'(B) CROP--  ',2A8//25X,'(C) SOIL TYPE--  ',I3,
     9'   (SCS) SOIL TYPE'//25X,'(D) DISPOSAL RATE--  ',F5.2,
    1l'  INCHES/DAY ON DISPOSAL DAYS'//25X,'(E) IRRIGATION MANAGEMENT--
    12  IRRIGATION BELOW  ',F5.2,'  AVAILABLE MOISTURE')
C
C         ***** ENTER YEARLY LCOP *****
C
      DO 1500 NY=1,YEARS
      DO 140 I=1,13
      DO 120 J=1,8
      PDACCT(I,J)=0.0
  120 SMACCT(I,J)=0.0
  140 CONTINUE
      IDISDA=0.0
      MAXVOL=0.0
      LKEVPT=0.0
      YRPET=0.0
      SMREVP=0.0
      IF(NY.GT.1) MSTART=1
      WRITE(6,160)
  160 FORMAT('1',46X,'***** ANNUAL SUMMARY *****')
C
C         ***** ENTER MONTHLY LOOP *****
C
      DO 1280 NM=MSTART,12
C
C
  180 READ(1,200,END=1520) KAN,STIND,YEAR,MONTH,(PREC(I),I=1,31),
     1(TMAX(I),I=1,31),(TMIN(I),I=1,31)
  200 FORMAT(I2,I4,2I2,31F4.2,62F3.0)
      IF(STIND.NE.INDST) GO TO 180
      IF(YEAR.LT.YSTART-1900) GO TO 180
      IF(YEAR.GT.YEND-1900) GO TO 1520
      IF(MONTH.LT.MSTART.AND.YEAR.EQ.YSTART-1900) GO TO 180
      IF(NM.NE.MONTH) GO TO 1490
      DSDAY=0
      NDIM(2)=28
      IF(NM.EQ.2.AND.TMAX(29).LT.900) NDIM(2)=29
      NDAYS=NDIM(NM)
C
C         ***** ENTER DAILY LOOP *****
C
      DO 1240 ND=1,NDAYS
C
C***  THE FOLLOWING STATEMENTS CORRECT FOR MISSING DATA ON INPUT TAPE
      IF(TMAX(ND).GT.250.0) TMAX(ND)=PDT+100.0
      IF(TMIN(ND).GT.250.0) TMIN(ND)=PDT+100.0
      IF(PREC(ND).GT.99.97) PREC(ND)=0.0
C***  THE FOLLOWING CARD EVALUATES WHETHER THE 24 HOUR DESIGN STORM
C***  HAS BEEN EXCEEDED.
      IF(PREC(ND).GE.STORM/1.14) WRITE(6,220) NM,ND,YEAR,PREC(ND)
  220 FORMAT(20X,I2,'/',I2,'/',I2,'  CRITICAL EVENT EXCEEDED  ',
     12X,F10.2,'  INCH STORM  ')
C
C     *** CALCULATION OF POTENTIAL EVAPOTRANSPIRATION BY MEANS OF
C                          PENMAN COMBINATION EQUATION ***
C
      R=RCROP
C***  THE FOLLOWING CARD CHECKS FOR SNOW COVER
      IF(PACK.GT.0.1) R=0.70
C***  TAVG IS THE AVERAGE DAILY AIR TEMPERATURE, DEGREE FAHRENHEIT
      TAVG(ND)=(TMAX(ND)+TMIN(ND))/2.0-100.0
C***  CONVERT AVG. DAILY TEMPERATURE TO ABSOLUTE, DEGREES KELVIN
      CENTMX=(TMAX(ND)-132.0)*100.0/180.0
      CENTMN=(TMIN(ND)-132.0)*100.0/180.0
      CENT=(CENTMX+CENTMN)/2.0
      ABST=CENT+273.16
C***  ES IS THE DAILY CALCULATED SATURATED VAPOR PRESSURE, IN MILLIBAR
      ES1=33.9*((0.00738*CENTMX+0.8072)**8-0.000019*ABS(1.8*CENTMX+48)
     1 +0.00136)
      ES2=33.9*((0.00738*CENTMN+0.8072)**8-0.000019*ABS(1.8*CENTMN+48)
     1 +0.00136)
      ES=(ES1+ES2)/2.0
      IF(ES.LE.0.0) ES=0.0
C***  ESA IS THE DEW POINT VAPOR PRESSURE, IN MILLIBARS
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      ESA=ES*RHD(NM)/100.0
C***  RN IS THE CALCULATED DAILY NET RADIATION, IN MM CF WATER
      RN=(1-R)*RA(NM)*(0.22+0.54*PSUNS(NM))-2.010E-09*ABST**4*(0.98*
     1(1.0-(BRUNTA+BRUNTB*SQRT(ESA))))*(0.1+0.9*PSUNS(NM))
      IF(RN.LT.0.0) RN=0.0
C***  WINDD IS THE MONTHLY AVERAGE WINDRUN, MILES/DAY AT 2 METERS
C***                                      HEIGHT
      WINDD=(WIND(NM)*24)*0.555
C***  EA IS THE CONVECTIVE LOSSES, MM WATER
      EA=0.26*(E+0.01*WINDD)*(ES-ESA)
      EALAKE=0.26*(EPRIM+0.01*WINDD)*(ES-ESA)
      IF(TAVG(ND)) 240,240,260
  240 DELTA=0.0
      GO TO 280
  260 DELTA=0.039*TAVG(ND)**0.673
  280 GAMMA=1-DELTA
C***  PET IS THE CALCULATED DAILY POTENTIAL EVAPOTRANSPIRATION, INCHES
      PET=((DELTA*RN)+(GAMMA*EA))/25.4
C***  CALCUATE LAKE AND BARE SOIL EVAPORATION
      RNSOIL=RN*((1.0-0.20)/(1.0-R))
      RNLAKE=RN*((1.0-0.05)/(1.0-R))
      PETBS=((DELTA*RNSOIL)+(GAMMA*EA))/25.4
      LAKEVP=((DELTA*RNLAKE)+(GAMMA*EALAKE))/25.4
      PDT=TAVG(ND)
      IF(TAVG(ND).LT.20.0) PET=0.0
      IF(TAVG(ND).LT.20.0) PETBS=0.0
      IF(TAVG(ND).LT.20.0) LAKEVP=0.0
      YRPET=YRPET+PET
      IAADD=IAET-PET
      IF(KCROP(CROP,NM).EQ.0.0) IAADD=IAET-PETBS
      IF(IAADD.GT.0.1) IAADD=0.1
      IF(IAADD.LT.0.0) IAADD=0.0
C
C     ***  CALCULATICN OF MOISTURE ADDED TO DISPOSAL AREA DUE TO
C                           SNOWMELT ON THE AREA  ***
C
C
      SNOVAP=0.0
      M=0.0
      PRECIP=PREC(ND)
      WATER=PRECIP
      IF(PACK.GT.0.1) SNOVAP=PET
      PACK=PACK-SNOVAP
      IF(SNOVAP.GT.0.0) PET=0.0
      IF(TAVG(ND)-32) 300,300,320
  300 IF(PRECIP) 420,420,340
  320 IF(PACK) 460,460,360
  340 PACK=PACK+PRECIP
      WATER=0.0
      GO TO 460
C***  MA IS SNOWMELT DUE TO ATMOSPHERIC CONDITIONS
  360 MA=0.05*(TAVG(ND)-34)
      IF(MA.LT.0.0) MA=0.0
      IF(PACK-MA) 400,400,380
C***  MR IS SNOWMELT DUE TO RAIN
  380 MR=(PRECIP*(TAVG(ND)-32))/144
      M=MR+MA
      IF(PACK-M) 400,420,420
  400 M=PACK
      PACK=0.0
      GO TO 440
  420 PACK=PACK-M
  440 WATER=M+PRECIP
C
C
C         *** EVALUATION OF SOIL MOISTURE AND CALCULATION OF ACTUAL
C                  EVAPOTRANSPIRATION FROM DISPOSAL AREA ***
C
  460 RAIN=WATER+(DISVOL/DSAREA)
      IF(DISVOL.GT.0.0.AND.PRECIP.LT.0.4) GO TO 600
      IF(RAIN.LE.0.0) GO TO 580
C***  CALCULATE SURFACE RUNOFF VOLUME BY SCS METHOD
      IF(KCROP(CROP,NM).LE.0.0) GO TO 520
      IF(SMUZ.LT.(PWPUZ(SOIL)+0.5*AVLFCU(SOIL))) GO TO 480
      IF(SMUZ.GT.(PWPUZ(SOIL)+0.8*AVLFCU(SOIL))) GO TO 500
      GO TO 540
C***  MODIFY RUNOFF CURVE NUMBER TO CONDITION I ANECEDENT MOISTURE
  480 RCM(SOIL,CROP)=RCN(SOIL,CROP)*0.39*EXP(0.009*RCN(SOIL,CROP))
      GO TO 560
C***  MODIFY RUNOFF CURVE NUMBER TO CONDITION III ANECEDENT MOISTURE
  500 RCM(SOIL,CROP)=RCN(SOIL,CROP)*1.95*EXP(-0.00663*RCN(SOIL,CROP))
      GO TO 560
  520 IF(SMUZ.LT.0.6*FCU(SOIL)) GO TO 480
      IF(SMUZ.GT.0.9*FCU(SOIL)) GO TO 500
  540 RCM(SOIL,CROP)=RCN(SOIL,CROP)
  560 SI=1000.0/RCM(SOIL,CROP)-10.0
      ER=RAIN-0.2*SI
      IF(ER.LT.0.0) GO TO 600
      RNOF=ER**2/(RAIN+0.8*SI)
      GO TO 620
C***  EVALUATE INTERCEPTION STORAGE
  580 RNOF=0.0
      IA=0.0
      GO TO 640
  600 RNOF=0.0
  620 IA=0.1
      IF(IA.GT.RAIN) IA=RAIN
      IF((IA+IAADD).GE.0.1) IA=0.1-IAADD
C***  EVALUATE PERCOLATION INTO UPPER ZONE
  640 PERC=RAIN-RNOF-IA
      UZEVAP=0.0
C***  CALCULATE PRESENT STORAGE AVAILABLE IN UPPER ZONE
      SMMAXU=0.9*SMSATU(SOIL)-SMUZ
C***  EVALUATE WATER CASCADED TO LOWER ZONE FOR STORAGE
      PERCL=PERC-SMMAXU
      IF(PERC.GT.SMMAXU) PERC=SMMAXU
      IF(PERCL.LT.0.0) PERCL=0.0
      IF (SMUZ.GT.FCU(SOIL)) GO TO 660
      EXCESS=0.0
      GO TO 680
C***  EVALUATE GRAVITATIONAL WATER IN UPPER ZONE
  660 EXCESS=SMUZ-FCU(SOIL)
C***  IF THE CROP IS DORMANT OR THE SOIL LIES FALLOW, SOIL
C***  EVAPORATION IS EVALUATED
  680 IF(KCROP(CROP,NM).LE.0.0) GO TO 860
      T=0.0
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C***  MODIFY PET BY THE PLANT CONSUMPTIVE USE COEFFICIENT
      AET=KCROP(CROP,NM)*PET
      IF(PET.LE.IAET) AET=0.0
C***  CHECK WHETHER SOIL MOISTURE LIMITS AET FROM THE UPPER ZONE
      IF(SMUZ-(0.3*(AVLFCU(SOIL))+PWPUZ(SOIL)))700,700,760
C***  CALCUATE AET FROM THE UPPER ZONE WHEN LIMITED BY SOIL MOISTURE
  700 AVAILU=SMUZ-PWPUZ(SOIL)
      IF(AVAILU.LE.0.0) AVAILU=0.0
      AETUZ=0.7*AET*(AVAILU/(0.3*AVLFCU(SOIL)))
C***  EVALUATE AVAILABLE WATER IN THE LOWER ZONE
      AVAILL=SMLZ-PWPLZ(SOIL)
      IF(AVAILL.LE.0.0) AVAILL=0.0
C***  CHECK WHETHER SOIL MOISTURE LIMITS AET FROM THE LOWER ZONE
      IF(SMLZ-(0.3*(AVLFCL(SOIL))+PWPLZ(SOIL))) 720,720,740
C***  CALCUATE AET FROM THE LOWER ZONE WHEN LIMITED BY SOIL MOISTURE
  720 AETLZ=0.3*AET*(AVAILL/(0.3*AVLFCL(SOIL)))
      GO TO 780
  740 AETLZ=AET-AETUZ
      GO TO 780
C***  EVALUATE AET FROM BOTH ZONES UNDER WET CONDITIONS
  760 AETUZ=0.7*AET
      AETLZ=0.3*AET
      AVAILL=SMLZ-PWPLZ(SOIL)
      IF(SMLZ.LE.0.3*(AVLFCL(SOIL))+PWPLZ(SOIL)) GO TO 720
  780 IF(PERC-SMMAXU) 800,820,820
C***  EVALUATE SOIL MOISTURE
  800 SMUZ=SMUZ+PERC-AETUZ-EXCESS
      SMLZ=SMLZ-AETLZ+EXCESS
      GO TO 960
  820 SMUZ=SMUZ+SMMAXU-EXCESS-AETUZ
  830 SMMAXL=0.9*FCL(SOIL)-SMLZ
      IF(PERCL+EXCESS-SMMAXL) 840,840,850
  840 SMLZ=SMLZ+PERCL-AETLZ+EXCESS
      GO TO 960
  850 SMLZ=SMLZ+SMMAXL-AETLZ
      DPERC=PERCL+EXCESS-SMMAXL
      GO TO 970
C***  CALCULATE EVAPORATION FROM BARE SOIL SURFACE(SEVAP) FOR MONTHS
C***  OCTOBER THROUGH MARCH OR WHEN THE DISPOSAL AREA IS FALLOW
  860 AETUZ=0.0
      AETLZ=0.0
      IF(PACK.GT.0.0) GO TO 920
      IF(SMUZ.LT.(FCU(SOIL)-U(SOIL))) GO TO 880
      EO=FCU(SOIL)-SMUZ
      IF(SMUZ.GE.FCU(SOIL)) EO=0.0
C***  CALCULATE STAGE 1 SOIL EVAPORATION
      UZEVAP=PETBS
      EO=EO+UZEVAP
      IF(EO.GT.U(SOIL)) UZEVAP=EO-U(SOIL)
      T=0.0
      GO TO 900
C***  CALCULATE STAGE 2 SOIL EVAPORATION
  880 T=T+1
      UZEVAP=C(SOIL)*(T**0.5)-C(SOIL)*((T-1)**0.5)
  900 IF(UZEVAP.GT.(PETBS-IAET)) UZEVAP=PETBS-IAET
      IF(UZEVAP.LT.0.0) UZEVAP=0.0
      IF(SMUZ-PWPUZ(SOIL).LT.UZEVAP) UZEVAP=SMUZ-PWPUZ(SOIL)
      GO TO 940
  920 UZEVAP=0.0
  940 SMUZ=SMUZ-UZEVAP+PERC-EXCESS
      IF(SMUZ.LE.PWPUZ(SOIL)) SMUZ=PWPUZ(SOIL)
      GO TO 830
  960 IF(SMLZ.LT.PWPLZ(SOIL)) AETLZ=AETLZ-(PWPLZ(SOIL)-SMLZ)
      IF(SMLZ.LE.PWPLZ(SOIL)) SMLZ=PWPLZ(SOIL)
      DPERC=SMLZ-0.9*FCL(SOIL)
      IF(DPERC.LT.0.0) DPERC=0.0
      IF(SMLZ.GT.0.9*FCL(SOIL)) SMLZ=0.9*FCL(SOIL)
  970 AETUZ=AETUZ+UZEVAP
C***  SM IS SOIL THE MOISTURE IN THE GROWING ZONE, IN INCHES
      SM=SMUZ+SMLZ
      IAET=IA+IAADD
C
C
C                   *** EVALUATION OF VOLUME DISPOSED ***
C
C***  T1 IS THE PREVIOUS DAY'S AVERAGE TEMPERATURE, IN FAHRENHEIT
C***  DEGREES, T2 IS THE AVERAGE TEMPERATURE OF THE DAY TWO DAYS
C***  PRIOR TO TODAY
      THAWED=TAVG(ND)+T1+T2
      FREEZE=TAVG(ND)+T1
      T2=T1
      T1=TAVG(ND)
      IF(FREEZE.LT.64.0) FROZE=1
      IF(THAWED.GT.114.0) FROZE=0
C***  WHEN FROZE EQUALS 1 THE SOIL IS CONSIDERED TO BE FROZEN IT IS
C***  THAWED WHEN FROZE EQUALS 0
      IF(FROZE.EQ.1) GO TO 980
C***  SMUZ IS THE SOIL MOISTURE IN THE TOP 12 INCHES OVER THE DISPOSAL
C***  AREA; AVLFCU IS THE AVAILABLE WATER CAPACITY OF THAT SOIL.
C***  IRRIGATION WILL NOT OCCUR ON DAYS THAT THE SOIL MOISTURE IS AT
C***  A LEVEL GREATER THAN THAT OF THE PERCENTAGE OF AVAILABLE WATER
C***  SPECIFIED BY THE VARIABLE PAVLU.
      IF(PAVLU.EQ.0.0) GO TO 980
      IF(SMUZ.GT.(PAVLU*AVLFCU(SOIL))+PWPUZ(SOIL)) GO TO 980
      IDISDA=IDISDA+1
      IF(PONVOL.LT.PCVMAX*VOLMAX) GO TO 930
      DISVOL=DSRATE*DSAREA
C***  IF THE POND VOLUME IS LESS THAN THE PERCENTAGE OF THE MAXIMUM
C***  POND VOLUME SPECIFIED BY PCUMAX, IT WILL BE ASSUMED THAT NO
C***  IRRIGATION WILL OCCUR ON THAT DAY.
      PONVOL=PONVOL-DISVOL
      IF(PONVOL.GT.0.0) GO TO 1000
      DISVOL=DISVOL+PONVOL
      PONVOL=0.0
      GO TO 1000
  980 DISVOL=0.0
C
C
C***  UPDATE DISPOSAL DAY ACCOUNT
 1000 IF(DISVOL.GT.0.0) DSDAY=DSDAY+1
C
C
C                   *** CALCULATION OF FEEDLOT RUNOFF ***
C
C***  CALCULATE 3 DAY ANTECEDENT MOISTURE
      AM=P1+P2+P3
      P1=P2
      P2=P3
      P3=PRECIP
      IF (SNOW.GT.0.0.AND.FROZE.EQ.0) GO TO 1020
      IF(PRECIP.LE.0.0) GO TO 1100
      IF (FROZE.EQ.1) GO TO 1080
      IF(AM.LE.0.5.AND.PRECIP.LE.0.5) GO TO 1100
C***  CALCULATE FEEDLOT RUNOFF USING 3 DAY ANTECEDENT MOISTURE
C***  CONDITIONS AND A MODIFICATION OF THE SCS METHOD
 1020 AM1=AM+PRECIP
      PRESIP=PRECIP+SNOW
      RC=97.0
      IF(MONTH.LT.4.OR.MONTH.GT.10) GO TO 1040
      IF(AM.LT.0.75) RC=91.0
      IF(AM1.GT.GROW.AND.PRECIP.GT.GROW) PRESIP=GROW
      GO TO 1060
 1040 IF(AM.LT.0.50) RC=91.0
      IF (SNOW.GT.0.0) RC=97.0
      IF(AM1.GT.DCRM.AND.PRECIP.GT.CORM) PRESIP=DCRM
 1060 CS=1000.0/RC-10.0
      RUNOFF=(PRESIP-0.2*CS)**2/(PRESIP+0.8*CS)
      RUNOFF=RUNOFF+PRECIP-PRESIP+SNOW
      SNCW=0.0
      IF(RUNOFF.GT.0.06) RUNOFF=RUNCFF-0.06
      IF(PRESIP-0.2*CS.LT.0.0) GO TO 1100
      GO TO 1120
 1080 SNOW=SNOW+PRECIP
 1100 RUNOFF=0.0
C
C
C
C               *** CALCULATION OF SURFACE AREA AND DETERMINATION OF
C                   SURFACE EVAPORATICN FROM STCRAGE FACILITY ***
C
C***  THE FOLLOWING CALCULATION EXPRESSES THE VCLUME OF WATER IN THE
C***  STORAGE FACILITY IN CUBIC FEET.
 1120 IF(PCNVOL.LE.0.0) GO TO 1160
C
      V=PONVOL*3630
C***  THE FCLLOWING CALCULATIONS DETERMINE THE SURFACE AREA OF THE
C***  STORAGE FACILITY AS A FUNCTION OF STORAGE VOLUME.  AREA IS IN
C***  SQUARE FEET AND VOLUME IS IN CUBIC FEET.  THE STORAGE FACILITY
C***  IS SHAPED LIKE AN INVERTED FRUSTRUM CF A PYRAMID.  INPUT
C***  PARAMETERS TO SIZE THE FACILITY ARE LENGTH(L) OF THE BASE IN
C***  FEET, WIDTH OF THE BASE(W) IN FEET AND SLCPE OF THE INSIDE
C***  EMBANKMENTS GIVEN AS A RATIO OF RUN TO RISE(S).  IT IS ASSUMED
C***  THE PCND DOES NOT LEAK.  INPUTS TO THE STORAGE WILL BE RUNOFF
C***  AND PRECIPITATION.  LOSSES FROM IT INCLUDE EVAPORATION AND
C***  DISPOSAL VOLUME.  B2 IS THE AREA OF THE SURFACE LIQUID IN
C***  SQUARE FEET.
      HAPRX=(PONVOL/VOLMAX)*HMAX
 1140 VC=A1*HAPRX+A2*HAPRX**2+A3*HAPRX**3
      DV=V-VC
      DVDH=A1+A4*HAPRX+A5*HAPRX**2
      H=HAPRX+DV/DVDH
      IF(ABS(H-HAPRX).LT.0.1) GO TO 1160
      HAPRX=H
      GO TO 1140
 1160 IF (H.GT.HMAX) H=HMAX
      B2=(W+2.*S*H)*(L+2.*S*H)
      IF(FROZE.EQ.1) LAKEVP=0.0
      LKEVPT=LKEVPT+LAKEVP
      IF(NM.GE.5.AND.NM.LE.10) SMREVP=SMREVP+LAKEVP
C***  SEVAP IS THE VOLUME OF WATER EXTRACTED FRCM THE STORAGE FACILITY
C***  BY FREE SURFACE EVAPORATICN.
      SEVAP=B2*(LAKEVP/12)
      IF((SEVAP/3630).GT.PONVUL) SEVAP=PONVGL*3630
      PONVGL=PGNVCL-(SEVAP/3630)
      IF(PONVOL.LE.0.0) PONVOL=0.0
C
C***  THE VCLUMES OF CALCULATED RUNOFF FROM THE FEEDLOT AND
C***  PRECIPITATICN FALLING UN THE FACILITY ARE ADDED TO THE VCLUME OF
C***  WATER IN THE STORAGE FACILITY(ACRE-IN).
      PONVOL=PONVOL+(RUNOFF*LTAREA)+(PRECIP*PSAREA)
C
C***  THE VCLUME OF WATER REMAINING AT THE END OF THE DAY IS EXPRESSED
C***  IN ACRE-IN.
C
C
C***  THE FOLLOWING STATEMENTS DETERMINE WHETHER THE STORAGE FACILITY
C***  HAS OVERFLOWED AND IF SU, THE QUANTITY DISCHARGED
      DSCHRG=0.0
      IF(PUNVCL-VOLMAX)  1220,1220,1180
 1180 DSCHRG=PGNVOL-VOLMAX
      DSCVCL=DSCVOL+DSCHRG
      PONVOL=VOLMAX
      WRITE(6,1200) NM,ND,YEAR,DSCHRG
 1200 FORMAT(20X,I2,'/',I2,'/',I2,'  -  DISCHARGE OF',F10.2,' ACRE-IN')
      IF(DSCHRG.GE.PEAK) PEAK=DSCHRG
      IF(YEAR.GT.PREVYR.OR.CM.LT.1.0) MM=MM+1
      PREVYR=YEAR
      CM=CM+1.0
C
C
 1220 SMACCT(NM,2)=SMACCT(NM,2)+PRECIP
      SMACCT(NM,3)=SMACCT(NM,3)+DISVOL/DSAREA
      SMACCT(NM,4)=SMACCT(NM,4)+IA
      SMACCT(NM,5)=SMACCT(NM,5)+RNOF
      SMACCT(NM,6)=SMACCT(NM,6)+DPERC
      SMACCT(NM,7)=SMACCT(NM,7)+AETUZ+AETLZ+SNGVAP
      SMACCT(NM,8)=SMACCT(NM,8)+SM-SMPD
      SMPD=SM
      PDACCT(NM,3)=PDACCT(NM,3)+RUNCFF*LTAREA/DSAREA
      PDACCT(NM,6)=PDACCT(NM,6)+SEVAP/(3630*DSAREA)
      PDACCT(NM,7)=PDACCT(NM,7)+DSCHRG/DSAREA
      PDACCT(NM,8)=PDACCT(NM,8)+(PONVOL-PDVCL)/DSAREA
      PDVOL=PONVOL
      IF(PONVOL.GT.MAXVOL) MAXVCL=PONVOL
C
 1240 CONTINUE
C
C
C        ***** EXIT DAILY LOOP *****
C
      SMACCT(NM,1)=AMONTH(NM)
      PDACCT(NM,1)=AMONTH(NM)
      PDACCT(NM,2)=SMACCT(NM,2)*PSAREA/DSAREA
      PDACCT(NM,4)=DSDAY
      PDACCT(NM,5)=SMACCT(NM,3)
      DO 1260 J=2,8
      PDACCT(13,J)=PDACCT(13,J)+PDACCT(NM,J)
 1260 SMACCT(13,J)=SMACCT(13,J)+SMACCT(NM,J)
      SMACCT(13,1)=AMONTH(13)
      PDACCT(13,1)=AMONTH(13)
C
 1280 CONTINUE
C
C         ***** EXIT MONTHLY LOOP *****
C
      DSNOW=PACK-PACKPY
      PACKPY=PACK
      PCWW=((PDACCT(13,2)+PDACCT(13,3)-PDACCT(13,7))/
     1     (PDACCT(13,2)+PDACCT(13,3)))*100.
      WASTWW=WASTWW+PCWW
      IRRSUM=IRRSUM+SMACCT(13,3)
      DSRNFF=DSRNFF+SMACCT(13,5)
      DSPERC=DSPERC+SMACCT(13,6)
      DSDAYS=DSDAYS+PDACCT(13,4)
      TPREC=TPREC+SMACCT(13,2)
      IF((YEAR+1900).EQ.YSTART) DRY=SMACCT(13,2)
      IF(SMACCT(13,2).GE.WET) WET=SMACCT(13,2)
      IF(SMACCT(13,2).LE.DRY) DRY=SMACCT(13,2)
      WRITE(6,1300) YEAR
 1300 FORMAT('0',27X,'WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER
     1 DISPOSAL AREA) - 19',I2//9X,'------------------------------------
     2------------------------------------------------------------------
     3---------------'/29X,'INFLOWS',50X,'OUTFLCWS'/17X,'---------------
     4---------------',23X,'--------------------------------------'/
     59X,'MCNTH',3X,'PRECIPITATION',2X,'FEEDLCT RUNOFF',3X,'NO. DISPOSAL
     6 DAYS',3X,'DISPOSAL VOL.',2X,'SURFACE EVAP.',2X,'DISCHARGE',4X,
     7'CHANGE IN VOL.')
      WRITE(6,1320) ((PDACCT(I,K),K=1,8),I=1,13)
 1320 FORMAT(10X,A4,7X,F6.2,8X,F6.2,15X,F3.0,12X,F6.2,10X,
     1 F6.2,7X,F6.2,9X,F6.2)
      WRITE(6,1340) YEAR
 1340 FORMAT('0',35X,'WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 19',
     1I2/10X,'----------------------------------------------------------
     2--------------------------------------------------------'/32X,
     3 'INPUTS',38X,'OUTPUTS'/21X,'-----------------------------',3X, '
     4-----------------------------------------------------'/9X,'MONTH',
     57X,'PRECIPITATION',4X,'IRRIGATION',3X,'INTERCEPTION',2X,'SURFACE R
     6UNOFF',3X,'PERCOLATION',8X,'AET',8X,'CHANGE IN SM')
      WRITE(6,1360) ((SMACCT(I,K),K=1,8),I=1,13)
 1360 FORMAT(10X,A4,7F15.2)
      WRITE(6,1380) PCWW
 1380 FORMAT('0',10X,'PERCENT OF WASTEWATER CCNTROLLED=',F10.2)
      WRITE (6,1400) IDISDA
 1400 FORMAT('0',10X,'POTENTIAL DISPOSAL DAYS=',I4)
      WRITE(6,1420) PACK,DSNOW
 1420 FORMAT('0',10X,'PACK CN DECEMBER 31 =',F5.2,15X,
     1'CHANGE IN SNOW STORAGE=',F5.2)
      WRITE(6,1440)
 1440 FORMAT('0',10X,'INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN
     1SOIL MOISTURE')
```

```
      MAXVOL=MAXVOL*100.0/VOLMAX
      WRITE(6,1460) MAXVOL
 1460 FORMAT('0',10X,'PERCENT OF MAXIMUM POND VOLUME REQUIRED =',F7.2)
      TPEVAP=TPEVAP+YRPET
      WRITE(6,1470) YRPET
 1470 FORMAT('0',10X,'ESTIMATED POTENTIAL EVAPCTRANSPIRATION, INCHES =',
     1F6.2)
      EVAPLK=EVAPLK+LKEVPT
      WRITE(6,1480) LKEVPT
 1480 FORMAT('0',10X,'ESTIMATED LAKE EVAPORATION, INCHES =',F6.2)
      EVPSMR=EVPSMR+SMREVP
      PCTSMR=(SMREVP/LKEVPT)*100.0
      WRITE(6,1484) SMREVP,PCTSMR
 1484 FORMAT('0',10X,'MAY - OCTOBER LAKE EVAPORATION, INCHES =',
     1F6.2,' OR ',F4.1,' % OF ANNUAL')
      GO TO 1500
 1490 WRITE(6,1740)
      IYRC=IYRC+1
 1500 CONTINUE
C
C          ***** EXIT YEARLY LOOP *****
C
 1520 CONTINUE
      YEARS=YEARS-IYRC
      EVAP=EVAPLK/YEARS
      AVGPET=TPEVAP/YEARS
      SMRLK=EVPSMR/YEARS
      PCTLK=(SMRLK/EVAP)*100.0
      IF(MM.EQ.0)  MM=1
      CMNEW=CM
      CCUNT=CM/MM
      IF(CCUNT.EQ.0.0) MM=0
      IF(CM.EQ.0.0) CM=YEARS
      DSCRG=DSCVOL/CM
      CM=CMNEW
      CONTRL=WASTWW/YEARS
      IRRVCL=IRRSUM/YEARS
      RNFFDS=DSRNFF/YEARS
      PERCDS=DSPERC/YEARS
      DAYSDS=DSDAYS/YEARS
      APREC=TPREC/YEARS
      RANGE=WET-DRY
      WRITE(6,100)NAME,OF,CITY,AND,STATE,YSTART,YEND,STCRM,LTAREA,L,W,S,0000
     *HMAX,VOLMAX,PSAREA,DSAREA,KROP(CROP),SOIL,DSRATE,PAVLU
      WRITE(6,1540)
 1540 FORMAT(////,47X,'***** FINAL SUMMARY *****')
      WRITE(6,1550)
 1550 FORMAT('0',10X,'METEOROLOGICAL SUMMARY')
      WRITE(6,1560) EVAP
 1560 FORMAT('0',25X,'AVERAGE ANNUAL LAKE EVAPORATION=',F6.2,' INCHES')
      WRITE(6,1570) SMRLK,PCTLK
 1570 FORMAT('0',25X,'AVERAGE MAY - OCTOBER LAKE EVAPCRATION, INCHES =',
     1F6.2,' OR ',F4.1,' % OF ANNUAL')
      WRITE(6,1624) APREC
 1624 FORMAT('0',25X,'AVERAGE ANNUAL PRECIPITATION=',F6.2,' INCHES')
      WRITE(6,1625) AVGPET
 1625 FORMAT('0',25X,'AVERAGE ANNUAL POTENTIAL EVAPOTRANSPIRATION=',
     1F6.2,' INCHES')
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      WRITE(6,1626) RANGE,DRY,WET
 1626 FORMAT('0',25X,'PRECIPITATION RANGE=',F6.2,' INCHES    (FROM A LOW
     1OF',F6.2,' INCHES  TO A HIGH OF ',F6.2,' INCHES)')
      WRITE(6,1610)
 1610 FORMAT('0',10X,'SUMMARY OF POND OPERATIONS')
      WRITE(6,1580) MM
 1580 FORMAT('0',25X,'NO. OF YEARS HAVING A DISCHARGE=',I6)
      WRITE(6,1600) COUNT
 1600 FORMAT('0',25X,'AVERAGE NO. OF DISCHARGES / YEAR HAVING A DISCHARG
     1E=',F6.2)
      WRITE(6,1620) DSCRG
 1620 FORMAT('0',25X,'AVERAGE DISCHARGE=',F6.2,1X,'ACRE-INCHES')
      WRITE(6,1640) CONTRL
 1640 FORMAT('0',25X,'AVERAGE PERCENT OF WASTEWATER CONTROLLED=',F6.2)
      WRITE(6,1621) DSCVOL
 1621 FORMAT('0',25X,'TOTAL DISCHARGE VOLUME=',F9.2,' ACRE-INCHES')
      WRITE(6,1622) CM
 1622 FORMAT('0',25X,'TOTAL NO. OF DISCHARGES=',F4.0)
      WRITE(6,1623) PEAK
 1623 FORMAT('0',25X,'MAXIMUM DISCHARGE=',F6.2,' ACRE-INCHES')
      WRITE(6,1619)
 1619 FORMAT('0',10X,'SUMMARY OF DISPOSAL AREA')
      WRITE(6,1660) IRRVOL
 1660 FORMAT('0',25X,'AVERAGE ANNUAL DEPTH OF WASTEWATER APPLIED=',F6.2,
     1' INCHES OVER ENTIRE DISPOSAL AREA')
      WRITE(6,1680) RNFFDS
 1680 FORMAT('0',25X,'AVERAGE ANNUAL DISPOSAL AREA RUNOFF=',F6.2,' INCHE
     1S')
      WRITE(6,1700) PERCDS
 1700 FORMAT('0',25X,'AVERAGE ANNUAL DISPOSAL AREA PERCOLATION=',F6.2,'
     1INCHES')
      WRITE(6,1720) DAYSDS
 1720 FORMAT('0',25X,'AVERAGE ANNUAL NO. OF DISPOSAL DAYS=',F6.1)
 1740 FORMAT('0',9X,'WARNING - PROGRAM UNDERGOING STANDARD FIX-UP AS RES
     1ULT OF MISSING BLOCK OF DATA; SKIPPING TO FOLLOWING YEAR')
      STOP
      END
```

```
                                          SUBPROGRAMS CALLED
SYMBCL     LOCATION      SYMBOL     LOCATION      SYMBOL     LOCATION      SYMBOL     LOCATION      SYMBOL     LOCATION
IBCOM#        3F8        FRDNL#        3FC        CROPCO        400        FRXPI#        404        FRXPR#        408
SCRT          40C        EXP           410

                                             SCALAR MAP
SYMBOL     LOCATION      SYMBOL     LOCATION      SYMROL     LOCATION      SYMBOL     LOCATION      SYMBOL     LOCATION
AET           474        AETLZ         478        AETUZ         47C        B2            480        DISVOL        484
DPERC         488        EO            48C        EXCESS        490        IA            494        IAADD         498
IAET          49C        M             4A0        MA            4A4        MR            4A8        PACK          4AC
PACKPY        4B0        PDVOL         4B4        PERC          4B8        PONVOL        4BC        PI            4C0
P2            4C4        P3            4C8        SNOMLT        4CC        TOPERC        4D0        TIME          4D4
TPEVAP        4D8        TRNUF         4DC        TI            4E0        T2            4E4        EVPSMR        4E8
CROP          4EC        DAY           4F0        ICAY          4F4        IYRC          4F8        MM            4FC
PREVYR        500        SOIL          504        T             508        PDT           50C        SMLZ          510
SMMAXL        514        SMUZ          518        DRY           51C        PEAK          520        PREVDS        524
TPREC         528        WET           52C        AVAILL        530        AVAILU        534        CM            538
DSCVOL        53C        DSDAYS        540        DSPERC        544        DSRNFF        548        EVAPLK        54C
H             550        IRRSUM        554        SNOW          558        WASTWW        55C        NAME          560
OF            564        CITY          568        AND           56C        STATE         570        I             574
K             578        MGSB          57C        DGSB          580        MGSE          584        DGSE          588
A1            58C        L             590        W             594        A2            598        S             59C
A3            5A0        A4            5A4        A5            5A8        VOLMAX        5AC        HMAX          5B0
PSAREA        5B4        SMPD          5B8        YEARS         5BC        YEND          5C0        YSTART        5C4
STORM         5C8        LTAREA        5CC        DSAREA        5D0        DSRATE        5D4        PAVLU         5C8
NY            5DC        J             5E0        IDISDA        5E4        MAXVOL        5E8        LKEVPT        5EC
YRPET         5F0        SMREVP        5F4        MSTART        5F8        NM            5FC        KAN           600
STIND         604        YEAR          608        MONTH         60C        INDST         610        DSDAY         614
NCAYS         618        ND            61C        R             620        RCROP         624        CENTMX        628
CENTMN        62C        CENT          630        ABST          634        ES1           638        ES2           63C
ES            640        ESA           644        RN            648        BPUNTA        64C        BRUNTB        650
WINOD         654        EA            658        E             65C        EALAKE        660        EPRIM         664
DELTA         668        GAMMA         66C        PET           670        RNSOIL        674        RNLAKE        678
PETBS         67C        LAKEVP        680        SNOVAP        684        PRECIP        688        WATER         68C
RAIN          690        SI            694        ER            698        RNOF          69C        UZEVAP        6A0
SMMAXU        6A4        PERCL         6A8        SM            6AC        THAWED        6B0        FREEZE        6B4
FROZE         6B8        PCVMAX        6BC        AM            6C0        AM1           6C4        PRESIP        6C8
RC            6CC        GROW          6D0        DORM          6D4        CS            6D8        RUNOFF        6CC
V             6E0        HAPRX         6E4        VC            6E8        DV            6EC        DVDH          6F0
SEVAP         6F4        DSCHRG        6F8        DSNOW         6FC        PCWW          700        PCTSMR        704
EVAP          708        AVGPET        70C        SMRLK         710        PCTLK         714        CMNEW         718
CCUNT         71C        CSCRG         720        CONTRL        724        IRRVCL        728        RNFFOS        72C
PERCOS        730        DAYSDS        734        APREC         738        RANGE         73C

                                            ARRAY MAP
SYMBOL     LOCATION      SYMBOL     LOCATION      SYMBOL     LOCATION      SYMBOL     LOCATION      SYMBOL     LOCATION
MMAT          740        AMONTH        770        AVLFCL        7A4        AVLFCU        7D4        C             804
FCL           834        FCU           864        CAS1          894        CNS3          800        CNS5          8CC
CNS12         8E8        KCROP         904        NDIM          A54        PDACCT        A84        PREC          C24
PSUNS         CA0        PWPLZ         CD0        PWPUZ         D00        RA            D30        RCM           D60
RCN           E80        RHD          1000        SMACCT       1030        SMSATL       1100        SMSATU       1200
TAVG         1230        TMAX         12AC        TMIN         1328        U            13A4        WIND         13D4
KRUP         1408
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                                     NAMELIST MAP
SYMBOL    LOCATION         SYMBOL    LOCATION         SYMBOL    LOCATION         SYMBOL    LOCATION         SYMBOL    LOCATION
ALPHA       1478           BETA        1574


                                   FORMAT STATEMENT MAP
SYMBOL    LOCATION         SYMBOL    LOCATION         SYMBOL    LOCATION         SYMBOL    LOCATION         SYMBOL    LOCATION
    20      1640               60      1648              100      1658              160      18FC              200      191F
   220      1933             1200      1975             1300      19A5             1320      1B59             1340      1B82
  1360      1D14             1380      1D1F             1400      1D4C             1420      1D6F             1440      1DAE
  1460      1DF6             1470      1E28             1480      1E67             1484      1E97             1540      1EE2
  1550      1F05             1560      1F24             1570      1F59             1624      1FAC             1625      1FDE
  1626      201F             1610      2081             1580      20A4             1600      20CF             1620      210F
  1640      213C             1621      2171             1622      21A2             1623      21C6             1619      21F2
  1660      2213             1680      226D             1700      22A6             1720      22E4             1740      2314

   *OPTIONS IN EFFECT*  ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,MAP
   *OPTIONS IN EFFECT*  NAME = MAIN    , LINECNT =       60
   *STATISTICS*    SOURCE STATEMENTS =       466,PROGRAM SIZE =     19378
   *STATISTICS*  NO DIAGNOSTICS GENERATED
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```
0001            SUBROUTINE CROPCO (CROP,MGSB,DGSB,MGSE,DGSE,KCROP,NDIM,MMAT)
          C***  SUBROUTINE CROPCO CALCULATES THE CROP COEFFICIENTS FOR USE IN
          C***  THE MAIN PROGRAM.  THE CROP COEFFICIENTS ARE CALCULATED BY THE
          C***  PROCEDURES OUTLINED IN TECHNICAL RELEASE NO 21, IRRIGATION
          C***  WATER REQUIREMENTS, UNITED STATES DEPARTMENT OF AGRICULTURE,
          C***  SOIL CONSERVATION SERVICE, ENGINEERING DIVISION, APRIL 1967.
          C***  SLIGHT MODIFICATIONS HAVE BEEN MADE FOR ADAPTATION TO THE MODEL.
          C***  EQUATIONS FOR THE CROP GROWTH STAGE COEFFICIENT CURVES WERE
          C***  DEVELOPED WHICH ELIMINATES THE NECESSITY OF READING THE VALUES
          C***  FROM THE CURVES.  INPUTS TO THE SUBROUTINE INCLUDE THE CROP,
          C***  MONTH AND DAY GROWING BEGINS AND ENDS, NUMBER OF DAYS IN EACH
          C***  MONTH, AND THE MEAN MONTHLY AVERAGE TEMPERATURES IN FAHRENHEIT
          C***  DEGREES.
0002            INTEGER CROP,DGSB,DGSE
0003            INTEGER NDIM(12),SHIFT
0004            REAL MID(12)/12*0./,DBMD(12)/12*0./,ACC(12)/12*0./,PCGS(12)/12*0./
0005            REAL MMAT(12),KT(12),KCROP(7,12),PCGS1(12)
          C***  MGSB= MONTH GROWING SEASON BEGINS EXPRESSED NUMERICALLY IE 1-12
          C***  DGSB= DAY GROWING SEASON BEGINS EXPRESSED NUMERICALLY
          C***  MGSE= MONTH GROWING SEASON ENDS EXPRESSED NUMERICALLY IE 1-12
          C***  DGSE= DAY GROWING SEASON ENDS EXPRESSED NUMERICALLY
          C***  MID=MEDIAN DATES OF THE MONTHS IN THE GROWING SEASON
          C***  DBMD= DAYS BETWEEN MID DATES
          C***  ACC= ACCUMULATIVE DAYS IN GROWING SEASON
          C***  PCGS= PERCENT OF GROWING SEASON REACHED AT MID DATES
          C***  MMAT=MEAN MONTHLY AVERAGE TEMPERATURES
          C***  MGSB1=TEMPORARY STORAGE FOR MGSB
          C***  MGSE1=TEMPORARY STORAGE FOR MGSE
          C***  PCGS1=TEMPORARY STORAGE FOR PCGS
0006            MGSB1=MGSB
0007            MGSE1=MGSE
0008            IF(MGSB.GT.MGSE) GO TO 1
0009            GO TO 7
          C***  WHEN MGSB IS GREATER THAN MGSE SUCH AS IN WINTER WHEAT THE
          C***  SUBROUTINE "SHIFTS" OR ADDS 1 TO MGSB AND MGSE UNTIL MGSB = 13
          C***  WHICH CORRESPONDS TO JANUARY.  THIS SHIFT WAS NECESSARY TO
          C***  FACILITATE PROGRAM LOOPING.  AFTER CALCULATIONS ARE MADE THE
          C***  CROP COEFFICIENTS ARE  "SHIFTED" BACK TO THEIR ORIGINAL MONTHS.
          C*******************************************************************************
          C*******************************************************************************
          C*******************************************************************************
          C***                                                                         ***
          C***                                                                         ***
          C***                                                                         ***
          C***  *** CAUTION TO USER ***  THIS ROUTINE WILL NOT WORK IF THE             ***
          C***  GROWING SEASON EXCEEDS ONE YEAR.                                       ***
          C***                                                                         ***
          C***                                                                         ***
          C***                                                                         ***
          C*******************************************************************************
          C*******************************************************************************
          C*******************************************************************************
0010          1 SHIFT=13-MGSB
0011            MGSE=MGSE+SHIFT
0012            MGSB=1
0013          7 NPLUS=MGSB+1
0014            NMINUS=MGSE-1
0015            MID(MGSB)=((NDIM(MGSB)-DGSB)/2.)+DGSB
```

```
           DC 2 N=NPLUS,NMINUS
         2 MID(N)=NDIM(N)/2.0
           MID(MGSE)=DGSE/2.0
           DBMD(MGSB)=MID(MGSB)-DGSB
           DU 3 N=NPLUS,NMINUS
         3 DBMD(N)=NDIM(N-1)-MID(N-1)+MID(N)
           DBMD(MGSE)=NDIM(MGSE-1)-MID(MGSE-1)+DGSE
           ACC(MGSB)=DBMD(MGSB)
           DC 4 N=NPLUS,MGSE
         4 ACC(N)=ACC(N-1)+DBMD(N)
           ACC(MGSE)=ACC(MGSE)-MID(MGSE)
           DO 5 N=MGSB,MGSE
         5 PCGS(N)=(ACC(N)*100.)/(ACC(MGSE)+MID(MGSE))
           IF(MGSB1.LE.MGSE1) GO TO 8
           DO 9 N=1,12
           NN=N-SHIFT
           IF(NN.LE.0) NN=NN+12
           IF(NN.GT.MGSE1.AND.NN.LT.MGSB1) GO TO 31
           PCGS1(NN)=PCGS(N)
           GC TO 9
        31 PCGS1(NN)=0.0
         9 CONTINUE
           DO 11 N=1,12
        11 PCGS(N)=PCGS1(N)
         8 MGSB=MGSB1
           MGSE=MGSE1
           DO 16 J=1,12
      C***  KT IS A CLIMATIC COEFFICIENT APPLIED TO THE CRCP GROWTH
      C***  COEFFICIENT.  IT IS CALCULATED BY THE FOLLOWING EQUATION:
           KT(J)=.0173*MMAT(J)-.314
           IF(MMAT(J).LT.36.) KT(J)=.3
        16 CONTINUE
      C***  CRUP=1 FOR WHEAT
      C***  CROP=2 FOR SORGHUM
      C***  CRUP=3 FOR CURN
      C***  CRCP=4 FOR SOYBEANS
      C***  CROP=5 FUR PASTURE
      C***  CROP=6 FOR ALFALFA
      C***  CRCP=7 FOR FALLOW
           GO TO (10,20,30,40,50,60,70),CROP
        10 XBAR=50.
           A=1.39093399                                                WHEAT
           B=-0.00368378                                               WHEAT
           C=-0.00004976                                               WHEAT
           D=-0.00000233                                               WHEAT
           E=-0.00000004                                               WHEAT
           GC TO 1001
        20 XBAR=50.
           A=1.05528355                                              SORGHUM
           B=0.00198600                                              SORGHUM
           C=-0.00051577                                             SORGHUM
           D=0.00000045                                              SORGHUM
           E=0.00000011                                              SORGHUM
           GO TO 1001
        30 XBAR=50.
           A=1.02805328                                                 CURN
           B=0.00880046                                                 CORN
           C=-0.00031919                                                CORN
      D=-0.00000194                                                     CORN
      E=0.00000007                                                      CORN
      GO TO 1001
   40 XBAR=50.
      A=0.74790430                                                      SOYBEANS
      B=0.01474796                                                      SOYBEANS
      C=-0.00013486                                                     SOYBEANS
      D=-0.00000443                                                     SOYBEANS
      E=0.                                                              SOYBEANS
      GO TO 1001
C***  FOR PERENNIAL CROPS SUCH AS ALFALFA AND PASTURE, VALUES OF THE
C***  CROP COEFFICIENTS ARE BEST PLOTTED ON A MONTHLY BASIS THEREFORE
C***  EQUATIONS WERE NOT DEVELOPED.  MONTHLY VALUES WERE INTEGRATED
C***  WITHIN THE ROUTINE FOR PASTURE AND ALFALFA.
   50 KCROP(5,1)=0.49                                                   PASTURE
      KCROP(5,2)=0.57                                                   PASTURE
      KCROP(5,3)=0.73                                                   PASTURE
      KCROP(5,4)=0.85                                                   PASTURE
      KCROP(5,5)=0.90                                                   PASTURE
      KCROP(5,6)=0.92                                                   PASTURE
      KCROP(5,7)=0.92                                                   PASTURE
      KCROP(5,8)=0.91                                                   PASTURE
      KCROP(5,9)=0.87                                                   PASTURE
      KCROP(5,10)=0.79                                                  PASTURE
      KCROP(5,11)=0.67                                                  PASTURE
      KCROP(5,12)=0.55                                                  PASTURE
      DO 90 J=1,12                                                      PASTURE
      KCROP(5,J)=KCROP(5,J)*KT(J)                                       PASTURE
      IF(PCGS(J).LE.0.0) KCROP(5,J)=0.0                                 PASTURE
   90 CONTINUE                                                          PASTURE
      GO TO 1002
   60 KCROP(6,1)=0.63                                                   ALFALFA
      KCROP(6,2)=0.73                                                   ALFALFA
      KCROP(6,3)=0.86                                                   ALFALFA
      KCROP(6,4)=0.99                                                   ALFALFA
      KCROP(6,5)=1.08                                                   ALFALFA
      KCROP(6,6)=1.13                                                   ALFALFA
      KCROP(6,7)=1.11                                                   ALFALFA
      KCROP(6,8)=1.06                                                   ALFALFA
      KCROP(6,9)=0.99                                                   ALFALFA
      KCROP(6,10)=0.91                                                  ALFALFA
      KCROP(6,11)=0.78                                                  ALFALFA
      KCROP(6,12)=0.64                                                  ALFALFA
      DO 80 J=1,12                                                      ALFALFA
      KCROP(6,J)=KCROP(6,J)*KT(J)                                       ALFALFA
   80 IF(PCGS(J).LE.0.0) KCROP(6,J)=0.0                                 ALFALFA
      GO TO 1002
   70 XBAR=0.
      A=0.                                                              FALLOW
      B=0.                                                              FALLOW
      C=0.                                                              FALLOW
      D=0.                                                              FALLOW
      E=0.                                                              FALLOW
 1001 DO 1003 J=1,12
      Z=PCGS(J)-XBAR
      KCROP(CROP,J)=(A+B*Z+C*Z**2+D*Z**3+E*Z**4)*KT(J)
      IF (PCGS(J).LE.0.0) KCROP(CROP,J)=0.0
 1003 CONTINUE
 1002 CONTINUE
C***  SINCE THE MAIN PROGRAM APPLIES THE CROP CCEFFICIENT (KCROP) TO
C***  THE ENTIRE MONTH, THE KCRCP WAS PROPORTIONED ACCORDINGLY TO
C***  COMPENSATE FOR THIS.  THE NEXT TWO CARDS DO THIS.
      KCROP(CROP,MGSB)=KCRCP(CROP,MGSB)*(NDIM(MGSB)-DGSB+1)/NDIM(MGSB)
      KCROP(CROP,MGSE)=KCROP(CROP,MGSE)*DGSE/NDIM(MGSE)
      RETURN
      END
```

```
                                    SCALAR MAP
SYMBOL     LOCATION     SYMBOL     LOCATION     SYMBOL     LOCATION     SYMBOL     LOCATION     SYMBOL     LOCATION
MGSB1         148       MGSB          14C       MGSE1         150       MGSE          154       SHIFT         158
NPLUS         15C       NMINUS        160       DGSB          164       N             168       DGSE          16C
NN            170       J             174       CROP          178       XBAR          17C       A             .180
B             184       C             188       D             18C       E             190       Z             194

                                    ARRAY MAP
SYMBOL     LOCATION     SYMBOL     LOCATION     SYMBOL     LOCATION     SYMBCL     LOCATION     SYMBOL     LOCATION
NDIM          198       MID           19C       DBMD          1CC       ACC           1FC       PCGS          22C
MMAT          25C       KT            260       KCROP         290       PCGS1         294

  *OPTIONS IN EFFECT*  ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,MAP
  *OPTIONS IN EFFECT*  NAME = CROPCO   , LINECNT =         60
  *STATISTICS*    SOURCE STATEMENTS =        123,PROGRAM SIZE =      3368
  *STATISTICS*  NO DIAGNOSTICS GENERATED

  *STATISTICS*  NO DIAGACSTICS THIS STEP
```

```
F128-LEVEL LINKAGE EDITOR OPTIONS SPECIFIED LET,LIST,MAP
          DEFAULT OPTICN(S) USED -  SIZE=(159744,24576)

                                                          MODULE MAP

  CONTROL SECTION                        ENTRY

    NAME     ORIGIN  LENGTH                NAME    LOCATION     NAME    LOCATION     NAME    LOCATION     NAME    LOCATION

  MAIN           00    4B82
  CRCPCO       4B88     D28
  IHCSEXP *    58E0     192
                                         EXP         58E0
  IHCKAMEL*    5A78     AC3
                                         FRDNL#      5A78     FWRNL#     607C
  IHCFRXPI*    6540     141
                                         FRXPI#      6540
  IHCFRXPR*    6688     183
                                         FRXPR#      6688
  IHCECOMH*    6810     F61
                                         IBCOM#      6810     FDIOCS#    68CC     INTSWTCH    7756
  IHCCOMH2*    7778     65D
                                         SEQDASD     7AF0
  IHCSSQRT*    7DD8     145
                                         SQRT        7DD8
  IHCFCVTH*    7F20    1190
                                         ADCON#      7F20     FCVAOUTP   7FCA     FCVLOUTP    805A     FCVZOUTP    81AA
                                         FCVIOUTP    8550     FCVEOUTP   8A5A     FCVCOUTP    8C74     INT6SWCH    8F58
  IHCSLOG *    90C0     186
                                         ALOG10      90C0     ALOG       90D8
  IHCEFNTH*    9278     542
                                         ARITH#      9278     ADJSWTCH   9614
  IHCEFIOS*    97C0     F28
                                         FIOCS#      97C0     FIOCSBEP   97C6
  IHCFIOS2*    A6E8     52E
  IHCERRM *    AC18     5D4
                                         ERRMON      AC18     IHCERRE    AC30
  IHCUOPT *    B1F0     300
  IHCETRCH*    B4F0     28E
                                         IHCTRCH     B4F0     ERRTRA     B4F8
  IHCUATBL*    B780     208

 ENTRY ADDRESS       00
 TOTAL LENGTH      B988

****MAIN      DOES NOT EXIST BUT HAS BEEN ADDED TO DATA SET
```

```
STATION:   BELLEVILLE, KANSAS           1949  TO  1973


CRITICAL EVENT- 5.10 INCHES


FEEDLCT AREA- 40.00 ACRES


POND VARIABLES:

              (A) BASE DIMENSION-- 570.00  FEET BY  190.00  FEET

              (B) SIDE SLOPE--    RUN: RISE = 3.0 : 1

              (C) MAXIMUM DEPTH--   6.00  FEET

              (D) MAXIMUM POND VOLUME--     202.33 ACRE-INCHES

              (E) DIRECT RECEIVING AREA (FOR PRECIPITATION) --      3.14 ACRES


DISPOSAL AREA VARIABLES:

              (A) DISPOSAL AREA--    80.00  ACRES

              (B) CROP--  CORN

              (C) SOIL TYPE--    5   (SCS) SOIL TYPE

              (D) DISPOSAL RATE--   0.50  INCHES/DAY ON DISPOSAL DAYS

              (E) IRRIGATION MANAGEMENT--   IRRIGATICN BELCW   0.90  AVAILABLE MOISTURE
```

```
                              ***** ANNUAL SUMMARY *****

         WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1949
-----------------------------------------------------------------------------------------------------
              INFLOWS                                              OUTFLOWS
       ------------------------------                 --------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.      0.09           0.0               0.             0.0            0.0          0.0          0.09
 FEB.      0.02           1.20              0.             0.0            0.00         0.0          1.22
 MAR.      0.05           0.07              2.             1.00           0.05         0.0         -0.93
 APR.      0.07           0.11              2.             0.51           0.05         0.0         -0.37
 MAY       0.19           0.62              1.             0.50           0.19         0.0          0.13
 JUNE      0.26           1.23              3.             0.76           0.18         0.0          0.56
 JULY      0.18           1.00              5.             1.75           0.12         0.0         -0.69
 AUG.      0.17           0.65              2.             0.81           0.12         0.0          0.09
 SEPT      0.12           0.16              1.             0.18           0.11         0.0         -0.02
 OCT.      0.08           0.38              1.             0.46           0.08         0.0         -0.08
 NOV.      0.0            0.0               0.             0.0            0.00         0.0         -0.00
 DEC.      0.02           0.01              0.             0.0            0.00         0.0          0.03
 TOT.      1.26           5.63             17.             5.96           0.90         0.0          0.03
                   WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1949
-----------------------------------------------------------------------------------------------------
                    INPUTS                                  OUTPUTS
          ---------------------------     ------------------------------------------------
MONTH     PRECIPITATION    IRRIGATION    INTERCEPTION  SURFACE RUNOFF  PERCOLATION     AET    CHANGE IN SM
 JAN.         2.22            0.0            0.20          0.0             0.0          0.17      0.18
 FEB.         0.58            0.0            0.29          0.02            0.0          0.32      1.29
 MAR.         1.36            1.00           0.64          0.09            0.0          1.04      0.42
 APR.         1.78            0.51           0.81          0.25            0.0          1.93     -0.20
 MAY          4.88            0.50           1.19          0.58            0.0          1.82      1.78
 JUNE         6.65            0.76           1.17          1.93            0.0          3.81      0.49
 JULY         4.55            1.75           1.00          0.50            0.0          6.68     -1.88
 AUG.         4.26            0.81           0.81          0.28            0.0          6.18     -2.20
 SEPT         3.10            0.18           0.80          0.00            0.0          3.07     -0.59
 OCT.         2.02            0.46           0.48          0.18            0.0          0.93      0.89
 NOV.         0.0             0.0            0.0           0.0             0.0          1.00     -1.00
 DEC.         0.62            0.0            0.24          0.0             0.0          0.33     -0.02
 TOT.        32.02            5.96           7.62          3.82            0.0         27.29     -0.83
  PERCENT OF WASTEWATER CONTROLLED=     100.00

  POTENTIAL DISPOSAL DAYS= 151

  PACK ON DECEMBER 31 = 0.08             CHANGE IN SNOW STORAGE= 0.08

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  51.80

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 36.88

  ESTIMATED LAKE EVAPORATION, INCHES = 40.78

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.53 OR 82.2 % OF ANNUAL
```

```
                                   ***** ANNUAL SUMMARY *****

                 WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1950
-----------------------------------------------------------------------------------------------------------
                     INFLOWS                                                 OUTFLOWS
         ----------------------------                        ---------------------------------------
MONTH    PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE    CHANGE IN VOL.
 JAN.        0.00           0.09                0.                0.0           0.01         0.0            0.08
 FEB.        0.04           0.01                1.                0.13          0.01         0.0           -0.10
 MAR.        0.02           0.11                0.                0.0           0.05         0.0            0.08
 APR.        0.03           0.0                 0.                0.0           0.12         0.0           -0.09
 MAY         0.19           0.89                1.                0.20          0.10         0.0            0.78
 JUNE        0.02           0.0                 2.                0.75          0.06         0.0           -0.79
 JULY        0.22           0.82                3.                0.89          0.12         0.0            0.02
 AUG.        0.28           1.60                3.                1.36          0.13         0.0            0.39
 SEPT        0.18           1.59                2.                0.90          0.07         0.0            0.81
 OCT.        0.07           0.54                2.                1.00          0.10         0.0           -0.49
 NOV.        0.02           0.0                 1.                0.50          0.02         0.0           -0.50
 DEC.        0.01           0.03                1.                0.25          0.00         0.0           -0.21
 TOT.        1.08           5.66               16.                5.97          0.79         0.0           -0.01

                         WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1950
-----------------------------------------------------------------------------------------------------------
                        INPUTS                                     OUTPUTS
              ---------------------------   ----------------------------------------------------------
MONTH         PRECIPITATION    IRRIGATION   INTERCEPTION  SURFACE RUNOFF   PERCULATION       AET      CHANGE IN SM
 JAN.             0.02            0.0           0.03           0.0             0.0          0.19         -0.14
 FEB.             0.90            0.13          0.52           0.0             0.0          0.17          0.36
 MAR.             0.49            0.0           0.44           0.0             0.0          0.19         -0.13
 APR.             0.75            0.0           0.40           0.0             0.0          0.23          0.12
 MAY              4.94            0.20          0.88           0.87            0.0          1.49          1.90
 JUNE             0.54            0.75          0.64           0.0             0.0          3.60         -2.95
 JULY             5.53            0.89          1.30           0.15            0.0          4.42          0.55
 AUG.             7.12            1.36          1.32           1.43            0.0          4.49          0.74
 SEPT             4.61            0.90          0.58           1.67            0.0          2.85          0.91
 OCT.             1.86            1.00          0.32           0.89            0.0          1.14          0.51
 NOV.             0.51            0.50          0.24           0.03            0.0          0.80         -0.07
 DEC.             0.31            0.25          0.20           0.0             0.0          0.37         -0.01
 TOT.            27.58            5.97          6.87           5.05            0.0         19.93          1.79
  PERCENT OF WASTEWATER CONTROLLED=    100.00

  POTENTIAL DISPOSAL DAYS= 158

  PACK ON DECEMBER 31 = 0.0               CHANGE IN SNOW STORAGE=-0.08

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  72.23

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 36.90

  ESTIMATED LAKE EVAPORATION, INCHES = 38.96

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.38 OR 83.1 % OF ANNUAL
```

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                                     ***** ANNUAL SUMMARY *****
        7/12/51  -  DISCHARGE OF        10.82 ACRE-IN
        7/14/51  -  DISCHARGE OF         1.21 ACRE-IN

              WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1951
---------------------------------------------------------------------------------------------------------------
                    INFLOWS
         -------------------------------                                      OUTFLOWS
MONTH    PRECIPITATION  FEEDLOT RUNOFF                      ---------------------------------------
                                        NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VCL.
 JAN.        0.03           0.04              0.                0.0            0.00          0.0           0.07
 FEB.        0.07           0.36              1.                0.13           0.01          0.0           0.29
 MAR.        0.07           0.04              1.                0.42           0.04          0.0          -0.35
 APR.        0.17           0.85              3.                0.99           0.07          0.0          -0.04
 MAY         0.12           0.28              0.                0.0            0.18          0.0           0.23
 JUNE        0.33           1.53              2.                0.73           0.20          0.0           0.94
 JULY        0.32           2.53              8.                3.63           0.22          0.15         -1.15
 AUG.        0.11           0.04              0.                0.0            0.16          0.0          -0.01
 SEPT        0.19           0.69              2.                0.72           0.10          0.0           0.05
 OCT.        0.10           0.16              1.                0.25           0.06          0.0          -0.05
 NOV.        0.02           0.01              0.                0.0            0.02          0.0           0.02
 DEC.        0.01           0.0               0.                0.0            0.00          0.0           0.00
 TOT.        1.54           6.54             18.                6.86           1.06          0.15          0.01

                    WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1951
---------------------------------------------------------------------------------------------------------------
                   INPUTS
         ---------------------------                          OUTPUTS
MONTH                               ---------------------------------------------------------
         PRECIPITATION  IRRIGATION  INTERCEPTION  SURFACE RUNOFF  PERCULATION     AET     CHANGE IN SM
 JAN.        0.75          0.0          0.22           0.0            0.0         0.25        0.08
 FEB.        1.86          0.13         0.45           0.35           0.0         0.34        1.04
 MAR.        1.90          0.42         0.72           0.11           0.0         1.04        0.45
 APR.        4.40          0.99         0.73           1.11           0.0         2.26        0.88
 MAY         3.15          0.0          0.82           0.76           0.0         1.76        0.22
 JUNE        8.42          0.73         1.39           2.49           1.20        3.48        0.59
 JULY        8.03          3.63         1.48           2.85           1.67        6.26       -0.61
 AUG.        2.86          0.0          1.04           0.02           0.0         6.20       -4.40
 SEPT        4.71          0.72         1.03           0.38           0.0         3.08        0.94
 OCT.        2.42          0.25         0.80           0.29           0.0         0.78        0.79
 NOV.        0.58          0.0          0.25           0.00           0.0         0.60       -0.27
 DEC.        0.21          0.0          0.10           0.0            0.0         0.39       -0.28
 TOT.       39.29          6.86         9.05           8.36           2.87       26.44       -0.57

 PERCENT OF WASTEWATER CONTROLLED=     98.14

 POTENTIAL DISPOSAL DAYS= 113

 PACK ON DECEMBER 31 = 0.0                    CHANGE IN SNOW STORAGE= 0.0

 INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

 PERCENT OF MAXIMUM POND VOLUME REQUIRED = 100.00

 ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 35.81

 ESTIMATED LAKE EVAPORATION, INCHES = 38.52

 MAY - OCTOBER LAKE EVAPORATION, INCHES = 31.87 OR 82.7 % OF ANNUAL
```

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                              ***** ANNUAL SUMMARY *****

              WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1952
--------------------------------------------------------------------------------------------------------------
                 INFLOWS                                                   OUTFLOWS
        ----------------------------                 ------------------------------------------------
MONTH   PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VCL.
 JAN.       0.01           0.12                1.               0.16           0.00          0.0          -0.03
 FEB.       0.03           0.01                0.               0.0            0.01          0.0           0.03
 MAR.       0.11           0.53                1.               0.50           0.03          0.0           0.10
 APR.       0.13           0.33                1.               0.47           0.12          0.0          -0.13
 MAY        0.11           0.11                0.               0.0            0.17          0.0           0.05
 JUNE       0.06           0.22                1.               0.21           0.06          0.0           0.01
 JULY       0.06           0.12                1.               0.15           0.09          0.0          -0.07
 AUG.       0.23           0.96                3.               1.05           0.09          0.0           0.05
 SEPT       0.03           0.07                1.               0.14           0.01          0.0          -0.05
 OCT.       0.0            0.0                 0.               0.0            0.0           0.0           0.0
 NOV.       0.05           0.13                1.               0.17           0.0           0.0           0.02
 DEC.       0.04           0.10                0.               0.0            0.00          0.0           0.14
 TOT.       0.86           2.70               10.               2.85           0.59          0.0           0.12
                         WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1952
--------------------------------------------------------------------------------------------------------------
                  INPUTS                                    OUTPUTS
         ---------------------------     ---------------------------------------------------------
MONTH    PRECIPITATION   IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCULATION        AET      CHANGE IN SM
 JAN.        0.35           0.16          0.21           0.0            0.0            0.25         0.05
 FEB.        0.86           0.0           0.25           0.0            0.0            0.54        -0.15
 MAR.        2.68           0.50          0.75           0.16           0.0            0.83         1.66
 APR.        3.32           0.47          0.88           0.11           0.0            2.13         0.67
 MAY         2.74           0.0           0.66           0.06           0.0            1.76         0.26
 JUNE        1.64           0.21          0.51           0.0            0.0            4.19        -2.85
 JULY        1.46           0.15          0.61           0.0            0.0            3.56        -2.56
 AUG.        5.77           1.05          1.21           0.14           0.0            4.01         1.47
 SEPT        0.69           0.14          0.40           0.0            0.0            2.33        -1.90
 OCT.        0.0            0.0           0.0            0.0            0.0            0.16        -0.16
 NOV.        1.34           0.17          0.16           0.0            0.0            0.11         0.86
 DEC.        1.08           0.0           0.16           0.0            0.0            0.25         0.13
 TOT.       21.93           2.85          5.80           0.47           0.0           20.10        -2.52
 PERCENT OF WASTEWATER CONTROLLED=    100.00

 POTENTIAL DISPOSAL DAYS= 241

 PACK ON DECEMBER 31 = 0.92                  CHANGE IN SNOW STORAGE= 0.92

 INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

 PERCENT OF MAXIMUM POND VOLUME REQUIRED =  28.33

 ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 38.00

 ESTIMATED LAKE EVAPORATION, INCHES = 41.98

 MAY - OCTOBER LAKE EVAPORATION, INCHES = 34.58 OR 82.4 % OF ANNUAL
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                    ***** ANNUAL SUMMARY *****

       WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1953

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                 INFLOWS                                                 OUTFLOWS
       ------------------------------                      -----------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE     CHANGE IN VOL.
 JAN.      0.00           0.31                2.               0.46           0.00          0.0           -0.15
 FEB.      0.02           0.00                0.               0.0            0.02          0.0           -0.00
 MAR.      0.06           0.10                1.               0.13           0.03          0.0            0.03
 APR.      0.08           0.03                0.               0.0            0.04          0.0            0.06
 MAY       0.11           0.63                0.               0.0            0.13          0.0            0.61
 JUNE      0.14           0.29                3.               0.97           0.14          0.0           -0.68
 JULY      0.10           0.30                1.               0.30           0.11          0.0           -0.00
 AUG.      0.08           0.26                1.               0.21           0.13          0.0           -0.00
 SEPT      0.07           0.45                1.               0.50           0.03          0.0            0.09
 OCT.      0.05           0.10                1.               0.13           0.01          0.0           -0.00
 NOV.      0.13           0.76                1.               0.15           0.01          0.0            0.73
 DEC.      0.07           0.43                0.               0.0            0.01          0.0            0.49
 TOT.      0.91           3.67               11.               2.85           0.66          0.0            1.06

                  WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1953
-------------------------------------------------------------------------------------------------------
                     INPUTS                                      OUTPUTS
           ---------------------------   -------------------------------------------------------
MONTH      PRECIPITATICN    IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCOLATION     AET       CHANGE IN SM
 JAN.          0.06            0.46          0.28           0.0            0.0         0.25          0.92
 FEB.          0.44            0.0           0.42           0.0            0.0         0.21         -0.19
 MAR.          1.62            0.13          0.41           0.07           0.0         1.36         -0.08
 APR.          1.93            0.0           0.79           0.0            0.0         0.55          0.59
 MAY           2.87            0.0           0.50           0.39           0.0         1.30          0.68
 JUNE          3.66            0.97          1.12           0.24           0.0         3.47         -0.19
 JULY          2.58            0.30          0.75           0.00           0.0         4.62         -2.50
 AUG.          2.00            0.21          0.51           0.0            0.0         2.07         -0.37
 SEPT          1.89            0.50          0.36           0.00           0.0         1.90          0.12
 OCT.          1.21            0.13          0.47           0.0            0.0         0.38          0.49
 NOV.          3.19            0.15          0.50           0.38           0.0         0.51          1.96
 DEC.          1.76            0.0           0.16           0.46           0.0         0.41          0.72
 TOT.         23.21            2.85          6.27           1.54           0.0        17.03          2.14

  PERCENT OF WASTEWATER CONTROLLED=     100.00

  POTENTIAL DISPOSAL DAYS= 253

  PACK ON DECEMBER 31 = 0.0              CHANGE IN SNOW STORAGE=-0.92

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  48.44

  ESTIMATED POTENTIAL EVAPOTRANSPIRATICN, INCHES = 39.24

  ESTIMATED LAKE EVAPCRATION, INCHES = 43.29

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 34.60 OR 79.9 % CF ANNUAL
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                         ***** ANNUAL SUMMARY *****

        WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1954
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                 INFLOWS
         ------------------------------                                  OUTFLOWS
                                                             ---------------------------------------
MONTH   PRECIPITATION   FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.       0.00            0.0                1.                0.50           0.01          0.0          -0.51
 FEB.       0.03            0.03               2.                0.69           0.03          0.0          -0.66
 MAR.       0.01            0.0                0.                0.0            0.05          0.0          -0.05
 APR.       0.07            0.14               0.                0.0            0.04          0.0           0.17
 MAY        0.25            1.55               1.                0.50           0.18          0.0           1.12
 JUNE       0.08            0.22               3.                1.47           0.13          0.0          -1.29
 JULY       0.08            0.01               0.                0.0            0.08          0.0           0.00
 AUG.       0.35            1.73               5.                1.97           0.12          0.0          -0.00
 SEPT       0.06            0.15               0.                0.0            0.10          0.0           0.11
 OCT.       0.09            0.19               1.                0.31           0.07          0.0          -0.11
 NOV.       0.0             0.0                0.                0.0            0.0           0.0           0.0
 DEC.       0.01            0.0                0.                0.0            0.01          0.0           0.01
 TOT.       1.04            4.01              13.                5.45           0.82          0.0          -1.21

                       WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1954
-------------------------------------------------------------------------------------------------------
                 INPUTS                                          OUTPUTS
         ------------------------------    ------------------------------------------------------
MONTH   PRECIPITATION   IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCOLATION     AET      CHANGE IN SM
 JAN.       0.05           0.50          0.15           0.0            0.0         0.23         0.17
 FEB.       0.79           0.69          0.40           0.0            0.0         1.00         0.08
 MAR.       0.17           0.0           0.17           0.0            0.0         1.03        -1.03
 APR.       1.87           0.0           0.42           0.01           0.0         0.43         1.01
 MAY        6.42           0.50          1.01           1.89           0.0         1.62         2.41
 JUNE       2.15           1.47          0.86           0.19           0.0         3.89        -1.32
 JULY       1.94           0.0           0.62           0.0            0.0         4.92        -3.60
 AUG.       8.96           1.97          1.83           1.33           0.0         5.31         2.46
 SEPT       1.57           0.0           0.23           0.00           0.0         3.19        -1.86
 OCT.       2.25           0.31          0.77           0.0            0.0         0.73         1.07
 NOV.       0.0            0.0           0.0            0.0            0.0         0.75        -0.75
 DEC.       0.38           0.0           0.13           0.0            0.0         0.26        -0.02
 TOT.      26.55           5.45          6.59           3.41           0.0        23.37        -1.38

 PERCENT OF WASTEWATER CONTROLLED=    100.00

 POTENTIAL DISPOSAL DAYS= 222

 PACK ON DECEMBER 31 = 0.01            CHANGE IN SNOW STORAGE= 0.01

 INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

 PERCENT OF MAXIMUM POND VOLUME REQUIRED =  60.35

 ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 39.68

 ESTIMATED LAKE EVAPORATION, INCHES = 43.65

 MAY - OCTOBER LAKE EVAPORATION, INCHES = 34.29 OR 78.5 % OF ANNUAL
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                              ***** ANNUAL SUMMARY *****

               WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1955

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                  INFLOWS                                                    OUTFLOWS
        -------------------------------                       --------------------------------------
MONTH   PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.       0.04           0.0                0.                0.0           0.00          0.0           0.03
 FEB.       0.05           0.0                0.                0.0           0.0           0.0           0.05
 MAR.       0.01           0.81               2.                0.89          0.02          0.0          -0.08
 APR.       0.03           0.0                0.                0.0           0.04          0.0          -0.01
 MAY        0.08           0.13               0.                0.0           0.13          0.0           0.05
 JUNE       0.23           1.56               4.                1.72          0.16          0.0          -0.09
 JULY       0.05           0.01               0.                0.0           0.06          0.0          -0.00
 AUG.       0.01           0.0                0.                0.0           0.01          0.0          -0.00
 SEPT       0.23           1.61               0.                0.0           0.05          0.0           1.80
 OCT.       0.05           0.0                3.                1.50          0.09          0.0          -1.54
 NOV.       0.01           0.0                1.                0.24          0.02          0.0          -0.25
 DEC.       0.03           0.19               0.                0.0           0.00          0.0           0.21
 TOT.       0.82           4.32              10.                4.35          0.58          0.0           0.20
                        WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1955
-----------------------------------------------------------------------------------------------------------------
                      INPUTS                                     OUTPUTS
              ----------------------------    -------------------------------------------------------
MONTH         PRECIPITATION    IRRIGATION    INTERCEPTION  SURFACE RUNOFF   PERCULATION        AET      CHANGE IN SM
 JAN.             0.94            0.0            0.35           0.0            0.0            0.35         0.16
 FEB.             1.21            0.0            0.20           0.0            0.0            0.29         0.42
 MAR.             0.25            0.89           0.47           0.0            0.0            1.15        -0.11
 APR.             0.78            0.0            0.37           0.0            0.0            0.57        -0.16
 MAY              2.12            0.0            0.63           0.0            0.0            1.49        -0.00
 JUNE             5.56            1.72           1.09           2.23           0.0            3.21         1.15
 JULY             1.30            0.0            0.68           0.0            0.0            3.56        -2.94
 AUG.             0.22            0.0            0.16           0.0            0.0            0.41        -0.35
 SEPT             5.97            0.0            0.78           0.43           0.0            0.84         3.92
 OCT.             1.18            1.50           0.51           0.03           0.0            0.98         0.66
 NOV.             0.15            0.24           0.28           0.0            0.0            0.60         0.01
 DEC.             0.71            0.0            0.15           0.0            0.0            0.24         0.32
 TOT.            20.79            4.35           5.67           2.70           0.0           13.71         3.07

  PERCENT OF WASTEWATER CONTROLLED=     100.00

  POTENTIAL DISPOSAL DAYS= 181

  PACK ON DECEMBER 31 = 0.0              CHANGE IN SNOW STORAGE=-0.01

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN    SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  71.57

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 38.37

  ESTIMATED LAKE EVAPORATION, INCHES = 41.84

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 34.75 OR 83.1 % OF ANNUAL
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                            ***** ANNUAL SUMMARY *****

          WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1956
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               INFLOWS
       ----------------------------                                 OUTFLOWS
                                                      ------------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.      0.03          0.0               1.              0.21           0.00          0.0          -0.19
 FEB.      0.02          0.0               0.              0.0            0.0           0.0           0.02
 MAR.      0.00          0.42              1.              0.45           0.01          0.0          -0.05
 APR.      0.05          0.0               0.              0.0            0.05          0.0           0.00
 MAY       0.09          0.24              1.              0.25           0.03          0.0           0.05
 JUNE      0.23          1.14              1.              0.50           0.20          0.0           0.66
 JULY      0.08          0.37              2.              1.00           0.16          0.0          -0.71
 AUG.      0.05          0.0               0.              0.0            0.04          0.0           0.02
 SEPT      0.00          0.0               0.              0.0            0.02          0.0          -0.02
 OCT.      0.06          0.06              0.              0.0            0.05          0.0           0.08
 NOV.      0.02          0.00              0.              0.0            0.03          0.0          -0.01
 DEC.      0.00          0.0               0.              0.0            0.01          0.0          -0.01
 TOT.      0.62          2.23              6.              2.41           0.59          0.0          -0.15
                      WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1956
------------------------------------------------------------------------------------------------------
                 INPUTS
         ----------------------------                  OUTPUTS
                                      ---------------------------------------------------
MONTH     PRECIPITATION    IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCULATION      AET        CHANGE IN SM
 JAN.         0.66            0.21          0.10          0.0            0.0           0.33          -0.16
 FEB.         0.54            0.0           0.25          0.01           0.0           0.39           0.49
 MAR.         0.04            0.45          0.14          0.0            0.0           1.29          -0.93
 APR.         1.20            0.0           0.44          0.0            0.0           0.50           0.26
 MAY          2.18            0.25          0.62          0.0            0.0           1.88          -0.32
 JUNE         5.76            0.50          1.16          0.70           0.0           3.92           0.73
 JULY         2.15            1.00          0.86          0.34           0.0           5.71          -3.76
 AUG.         1.36            0.0           0.58          0.0            0.0           1.30          -0.52
 SEPT         0.01            0.0           0.01          0.0            0.0           0.61          -0.61
 OCT.         1.46            0.0           0.35          0.0            0.0           0.27           0.84
 NOV.         0.50            0.0           0.22          0.0            0.0           0.59          -0.31
 DEC.         0.04            0.0           0.04          0.0            0.0           0.32          -0.32
 TOT.        15.90            2.41          4.77          1.05           0.0          17.10          -4.60
 PERCENT OF WASTEWATER CONTROLLED=    100.00

 POTENTIAL DISPOSAL DAYS= 244

 PACK ON DECEMBER 31 = 0.0                  CHANGE IN SNOW STORAGE= 0.0

 INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

 PERCENT OF MAXIMUM POND VOLUME REQUIRED =  49.33

 ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 39.01

 ESTIMATED LAKE EVAPORATION, INCHES = 42.67

 MAY - OCTOBER LAKE EVAPORATION, INCHES = 35.35 OR 82.9 % OF ANNUAL
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                              ***** ANNUAL SUMMARY *****

               WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1957
------------------------------------------------------------------------------------------------------------
                  INFLOWS                                                 OUTFLOWS
        ------------------------------                      --------------------------------------
MONTH   PRECIPITATION   FEEDLOT RUNOFF   NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.       0.01            0.0                 0.              0.0            0.00          0.0           0.01
 FEB.       0.02            0.07                1.              0.14           0.02          0.0          -0.07
 MAR.       0.07            0.24                1.              0.26           0.03          0.0           0.02
 APR.       0.17            0.74                3.              0.86           0.05          0.0          -0.01
 MAY        0.17            0.47                1.              0.50           0.14          0.0          -0.00
 JUNE       0.30            1.51                3.              1.16           0.15          0.0          -0.00
 JULY       0.05            0.16                2.              0.66           0.06          0.0           0.51
 AUG.       0.20            1.33                4.              1.45           0.07          0.0          -0.51
 SEPT       0.08            0.21                1.              0.23           0.06          0.0          -0.00
 OCT.       0.06            0.04                0.              0.0            0.04          0.0          -0.00
 NOV.       0.06            0.17                1.              0.26           0.02          0.0           0.06
 DEC.       0.03            0.0                 0.              0.0            0.01          0.0          -0.06
 TOT.       1.21            4.93               17.              5.53           0.66          0.0           0.02
                                                                                                      -0.04
                          WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1957
------------------------------------------------------------------------------------------------------------
                  INPUTS                                         OUTPUTS
        ----------------------------   ----------------------------------------------------------
MONTH   PRECIPITATION   IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCOLATION     AET     CHANGE IN SM
 JAN.       0.28           0.0           0.11           0.0            0.0         0.10       -0.00
 FEB.       0.42           0.14          0.37           0.0            0.0         0.27        0.07
 MAR.       1.02           0.26          0.53           0.0            0.0         0.25        1.29
 APR.       4.20           0.86          1.02           0.27           0.0         1.67        2.10
 MAY        4.36           0.50          1.10           0.37           0.0         1.67        1.73
 JUNE       7.74           1.16          1.58           1.92           0.0         3.67        1.74
 JULY       1.16           0.66          0.54           0.10           0.0         6.61       -5.43
 AUG.       4.99           1.45          0.86           0.40           0.0         3.43        1.45
 SEPT       2.14           0.23          0.75           0.12           0.0         2.91       -1.10
 OCT.       1.52           0.0           0.58           0.0            0.0         0.75        0.19
 NOV.       1.46           0.26          0.52           0.0            0.0         0.48        0.72
 DEC.       0.68           0.0           0.15           0.0            0.0         0.48       -0.40
 TOT.      30.77           5.53          8.12           3.16           0.0        22.29        2.28
  PERCENT OF WASTEWATER CONTROLLED=    100.00

  POTENTIAL DISPOSAL DAYS= 217

  PACK ON DECEMBER 31 = 0.45              CHANGE IN SNOW STORAGE= 0.45

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  58.94

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 36.95

  ESTIMATED LAKE EVAPORATION, INCHES = 40.61

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.06 OR 81.4 % OF ANNUAL
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                    ***** ANNUAL SUMMARY *****
 9/ 5/58  CRITICAL EVENT EXCEEDED           7.03  INCH STORM
 9/ 5/58  -  DISCHARGE OF      71.58 ACRE-IN
 9/ 6/58  -  DISCHARGE OF      33.81 ACRE-IN

        WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1958

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                  INFLOWS                                                 OUTFLOWS
        -----------------------------                     ----------------------------------------
MONTH   PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE     CHANGE IN VOL.
 JAN.       0.05           0.08               0.                0.0            0.00         0.0             0.12
 FEB.       0.03           0.29               0.                0.0            0.01         0.0             0.31
 MAR.       0.12           1.15               1.                0.50           0.03         0.0             0.75
 APR.       0.07           0.04               3.                1.17           0.11         0.0            -1.17
 MAY        0.16           1.00               1.                0.50           0.19         0.0             0.48
 JUNE       0.14           0.34               2.                0.88           0.11         0.0            -0.51
 JULY       0.38           2.50               6.                2.70           0.18         0.0             0.01
 AUG.       0.06           0.06               0.                0.0            0.11         0.0             0.02
 SEPT       0.46           4.05               3.                1.50           0.16         1.32            1.54
 OCT.       0.01           0.0                2.                1.00           0.09         0.0            -1.08
 NOV.       0.04           0.05               1.                0.47           0.01         0.0            -0.40
 DEC.       0.00           0.02               0.                0.0            0.00         0.0             0.02
 TOT.       1.53           9.58              19.                8.72           0.99         1.32            0.08

                     WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1958
----------------------------------------------------------------------------------------------------------
                      INPUTS                                      OUTPUTS
            ----------------------------   -----------------------------------------------------------
MONTH       PRECIPITATION    IRRIGATION   INTERCEPTION  SURFACE RUNOFF   PERCOLATION       ACT        CHANGE IN SM
 JAN.           1.17            0.0           0.37           0.01            0.0           0.26           0.68
 FEB.           0.84            0.0           0.24           0.03            0.0           0.37           0.25
 MAR.           3.07            0.50          0.57           0.48            0.0           0.71           2.06
 APR.           1.82            1.17          0.99           0.10            0.0           2.23          -0.32
 MAY            4.18            0.50          0.66           1.02            0.0           1.79           1.21
 JUNE           3.63            0.88          1.01           0.40            0.0           3.69          -0.59
 JULY           9.70            2.70          1.97           3.72            0.0           6.28           0.42
 AUG.           1.62            0.0           0.65           0.0             0.0           5.70          -4.73
 SEPT          11.68            1.50          1.11           3.52            0.0           3.11           5.44
 OCT.           0.17            1.00          0.30           0.0             0.0           1.07          -0.20
 NOV.           0.92            0.47          0.23           0.00            0.0           0.88           0.11
 DEC.           0.08            0.0           0.21           0.0             0.0           0.31          -0.27
 TOT.          38.88            8.72          8.32           9.29            0.0          26.39           4.06

  PERCENT OF WASTEWATER CONTROLLED=     88.14

  POTENTIAL DISPOSAL DAYS=  98

  PACK ON DECEMBER 31 = 0.0               CHANGE IN SNOW STORAGE=-0.45

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED = 100.00

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 35.73

  ESTIMATED LAKE EVAPORATION, INCHES = 39.16

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.98 OR 84.2 % OF ANNUAL
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                                   ***** ANNUAL SUMMARY *****

                  WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1959
--------------------------------------------------------------------------------------------------------
                   INFLOWS                                                 OUTFLOWS
        -----------------------------                  ---------------------------------------------
MONTH   PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.       0.01           0.01                0.                0.0            0.00         0.0           0.02
 FEB.       0.03           0.37                1.                0.50           0.01         0.0          -0.10
 MAR.       0.09           0.43                0.                0.0            0.06         0.0           0.47
 APR.       0.04           0.0                 1.                0.49           0.04         0.0          -0.49
 MAY        0.25           1.22                1.                0.50           0.17         0.0           0.79
 JUNE       0.07           0.14                3.                0.91           0.08         0.0          -0.78
 JULY       0.06           0.04                0.                0.0            0.12         0.0          -0.01
 AUG.       0.06           0.23                1.                0.28           0.01         0.0          -0.00
 SEPT       0.19           1.06                1.                0.48           0.05         0.0           0.72
 OCT.       0.19           0.75                1.                0.50           0.08         0.0           0.36
 NOV.       0.0            0.0                 2.                1.00           0.02         0.0          -1.02
 DEC.       0.03           0.0                 0.                0.0            0.01         0.0           0.01
 TOT.       1.03           4.26               11.                4.67           0.65         0.0          -0.04

                         WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1959
--------------------------------------------------------------------------------------------------------
                      INPUTS                                       OUTPUTS
          ----------------------------   ----------------------------------------------------
MONTH     PRECIPITATION    IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCOLATION      AET      CHANGE IN SM
 JAN.          0.36           0.0           0.11           0.0            0.0          0.19        -0.14
 FEB.          0.81           0.50          0.27           0.00           0.0          0.39         0.36
 MAR.          2.27           0.0           0.76           0.19           0.02         1.18         0.61
 APR.          1.05           0.49          0.57           0.0            0.09         1.69        -0.81
 MAY           6.30           0.50          1.11           1.29           1.70         1.78         0.91
 JUNE          1.86           0.91          0.83           0.02           0.0          3.85        -1.93
 JULY          1.64           0.0           0.52           0.0            0.0          5.41        -4.29
 AUG.          1.40           0.28          0.37           0.0            0.0          1.28         0.03
 SEPT          4.93           0.48          0.90           0.76           0.0          2.09         1.66
 OCT.          4.84           0.50          0.76           1.21           0.0          0.76         2.60
 NOV.          0.0            1.00          0.20           0.0            0.0          0.64         0.16
 DEC.          0.64           0.0           0.13           0.0            0.0          0.63        -0.35
 TOT.         26.10           4.67          6.53           3.49           1.81        19.90        -1.19

 PERCENT OF WASTEWATER CONTROLLED=    100.00

 POTENTIAL DISPOSAL DAYS= 170

 PACK ON DECEMBER 31 = 0.23               CHANGE IN SNOW STORAGE= 0.23

 INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

 PERCENT OF MAXIMUM POND VOLUME REQUIRED =  57.71

 ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 37.80

 ESTIMATED LAKE EVAPORATION, INCHES = 41.57

 MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.75 OR 81.2 % OF ANNUAL
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                        ***** ANNUAL SUMMARY *****
          WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1960
--------------------------------------------------------------------------------------------------------
               INFLCWS
       ---------------------------                                 OUTFLCWS
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  ------------------------------------------
                                                        DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE    CHANGE IN VOL.
 JAN.      0.08           0.0              0.               0.0            0.0           0.0           0.08
 FEB.      0.05           0.82             0.               0.0            0.00          0.0           0.87
 MAR.      0.08           1.34             0.               0.0            0.01          0.0           1.41
 APR.      0.11           0.12             5.               2.40           0.13          0.0          -2.31
 MAY       0.11           0.17             1.               0.23           0.16          0.0          -0.11
 JUNE      0.25           0.98             2.               0.80           0.14          0.0           0.28
 JULY      0.09           0.05             1.               0.28           0.15          0.0          -0.28
 AUG.      0.18           0.54             2.               0.64           0.08          0.0          -0.00
 SEPT      0.12           0.64             2.               0.63           0.03          0.0           0.11
 OCT.      0.05           0.12             0.               0.0            0.08          0.0           0.09
 NOV.      0.01           0.0              1.               0.19           0.01          0.0          -0.18
 DEC.      0.02           0.0              0.               0.0            0.00          0.0           0.02
 TOT.      1.15           4.77            14.               5.16           0.79          0.0          -0.03
                    WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1960
--------------------------------------------------------------------------------------------------------
                 INPUTS
       -----------------------------                      OUTPUTS
MONTH  PRECIPITATION  IRRIGATION  ------------------------------------------------------
                                  INTERCEPTION  SURFACE RUNOFF  PERCOLATION    AET    CHANGE IN SM
 JAN.      1.94          0.0          0.26          0.00           0.0        0.19       0.35
 FEB.      1.38          0.0          0.19          0.01           0.0        0.24       1.34
 MAR.      2.00          0.0          0.21          0.71           1.20       0.52       0.34
 APR.      2.68          2.40         1.15          0.25           0.79       2.44       0.46
 MAY       2.70          0.23         0.83          0.38           0.76       1.75      -0.79
 JUNE      6.26          0.80         1.21          1.62           0.26       3.65       0.32
 JULY      2.22          0.28         0.87          0.0            0.0        6.45      -4.83
 AUG.      4.62          0.64         0.97          0.0            0.0        4.47      -0.18
 SEPT      3.12          0.63         0.57          0.14           0.0        2.49       0.55
 OCT.      1.37          0.0          0.27          0.03           0.0        0.92       0.15
 NOV.      0.38          0.19         0.20          0.0            0.0        0.75      -0.39
 DEC.      0.50          0.0          0.21          0.0            0.0        0.26      -0.00
 TOT.     29.17          5.16         6.93          3.13           3.01      24.13      -2.68
PERCENT OF WASTEWATER CONTROLLED=    100.00

POTENTIAL DISPOSAL DAYS= 142

PACK ON DECEMBER 31 = 0.04                CHANGE IN SNOW STORAGE=-0.20

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED =  98.53

ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 35.45

ESTIMATED LAKE EVAPORATION, INCHES = 38.96

MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.18 OR 85.2 % OF ANNUAL
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                                 ***** ANNUAL SUMMARY *****
          9/12/61  CRITICAL EVENT EXCEEDED          6.11  INCH STORM
          9/12/61  -  DISCHARGE OF      30.57 ACRE-IN
          9/13/61  -  DISCHARGE OF      47.07 ACRE-IN

                WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1961
-------------------------------------------------------------------------------------------------------------
                   INFLOWS
        ------------------------------                                   OUTFLOWS
MONTH   PRECIPITATION  FEEDLOT RUNOFF    NO. DISPOSAL DAYS   ------------------------------------------
 JAN.       0.00           0.07                 0.           DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE    CHANGE IN VOL.
 FEB.       0.02           0.07                 1.                0.0            0.00          0.0            0.07
 MAR.       0.13           0.36                 1.                0.19           0.00          0.0           -0.11
 APR.       0.07           0.10                 1.                0.34           0.05          0.0            0.10
 MAY        0.30           1.54                 1.                0.21           0.06          0.0           -0.10
 JUNE       0.15           0.83                 4.                0.50           0.18          0.0            1.16
 JULY       0.09           0.47                 1.                1.97           0.17          0.0           -1.16
 AUG.       0.09           0.18                 1.                0.50           0.07          0.0           -0.00
 SEPT       0.43           4.05                 3.                0.20           0.07          0.0           -0.00
 OCT.       0.08           0.35                 1.                1.50           0.10          0.97           1.91
 NOV.       0.09           0.42                 0.                0.50           0.09          0.0           -0.16
 DEC.       0.03           0.0                  0.                0.0            0.03          0.0            0.48
 TOT.       1.49           8.45                14.                0.0            0.01          0.0            0.03
                                                                  5.91           0.83          0.97           2.22
                          WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1961
-------------------------------------------------------------------------------------------------------------
                       INPUTS                                        OUTPUTS
              ---------------------------   ---------------------------------------------------
MONTH         PRECIPITATION     IRRIGATION   INTERCEPTION  SURFACE RUNOFF   PERCOLATION      AET       CHANGE IN SN
 JAN.             0.08             0.0           0.11           0.0             0.0          0.37         -0.37
 FEB.             0.42             0.19          0.29           0.0             0.0          0.24          0.08
 MAR.             3.27             0.34          0.73           0.58            0.0          1.10          1.21
 APR.             1.86             0.21          0.59           0.01            0.0          1.77         -0.30
 MAY              7.61             0.50          1.46           1.46            0.0          1.67          3.52
 JUNE             3.88             1.97          0.98           0.86            0.59         3.72         -0.29
 JULY             2.40             0.50          0.54           0.01            0.0          6.67         -4.31
 AUG.             2.25             0.20          0.73           0.0             0.0          3.40         -1.68
 SEPT            10.88             1.50          1.00           3.78            0.0          2.02          5.58
 OCT.             2.16             0.50          0.39           0.61            0.0          0.99          0.67
 NOV.             2.25             0.0           0.37           0.06            0.65         0.45          0.72
 DEC.             0.83             0.0           0.0            0.0             0.0          0.30         -0.19
 TOT.            37.89             5.91          7.19           7.37            1.24        22.70          4.62
  PERCENT OF WASTEWATER CONTROLLED=     90.23

  POTENTIAL DISPOSAL DAYS= 140

  PACK ON DECEMBER 31 = 0.72                  CHANGE IN SNOW STORAGE= 0.68

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED = 100.00

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 36.78

  ESTIMATED LAKE EVAPORATION, INCHES = 40.59

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.75 OR 80.7 % OF ANNUAL
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                                    ***** ANNUAL SUMMARY *****
          2/ 2/62  -  DISCHARGE OF      38.29 ACRE-IN

                    WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1962

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                    INFLOWS                                                   OUTFLOWS
        ------------------------------                      ----------------------------------------
MONTH   PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE      CHANGE IN VOL.
 JAN.        0.04          0.0                 0.                0.0           0.0           0.0             0.04
 FEB.        0.04          0.73                1.                0.50          0.02          0.48           -0.24
 MAR.        0.10          0.37                1.                0.50          0.05          0.0            -0.08
 APR.        0.03          0.0                 4.                1.91          0.09          0.0            -1.96
 MAY         0.18          1.03                0.                0.0           0.10          0.0             1.12
 JUNE        0.26          1.37                4.                2.00          0.23          0.0            -0.60
 JULY        0.19          0.38                4.                0.96          0.14          0.0            -0.53
 AUG.        0.12          0.24                0.                0.0           0.18          0.0             0.17
 SEPT        0.15          0.19                2.                0.38          0.08          0.0            -0.11
 OCT.        0.09          0.29                1.                0.21          0.05          0.0             0.13
 NOV.        0.03          0.01                1.                0.19          0.02          0.0            -0.16
 DEC.        0.03          0.0                 0.                0.0           0.01          0.0             0.02
 TOT.        1.24          4.61               18.                6.64          0.95          0.48           -2.21
                         WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1962
-----------------------------------------------------------------------------------------------------------
                        INPUTS                                   OUTPUTS
           ----------------------------   -------------------------------------------------
MONTH      PRECIPITATION     IRRIGATION   INTERCEPTION  SURFACE RUNOFF   PERCOLATION       AET        CHANGE IN SM
 JAN.          0.99             0.0          0.25          0.28            0.69           0.26          0.23
 FEB.          0.97             0.50         0.28          0.05            0.24           0.59         -0.04
 MAR.          2.42             0.50         0.79          0.34            1.26           0.85          0.04
 APR.          0.74             1.91         0.84          0.00            0.16           2.35         -0.71
 MAY           4.64             0.0          0.89          1.12            0.08           1.94          0.60
 JUNE          6.61             2.00         1.50          1.51            1.88           3.68          0.04
 JULY          4.81             0.96         1.30          0.23            0.0            6.37         -2.13
 AUG.          3.01             0.0          0.51          0.01            0.0            5.76         -3.26
 SEPT          3.70             0.38         1.37          0.00            0.0            2.81         -0.10
 OCT.          2.38             0.21         0.47          0.34            0.0            0.80         -0.98
 NOV.          0.70             0.19         0.36          0.0             0.0            0.65         -0.12
 DEC.          0.66             0.0          0.24          0.0             0.0            0.34         -0.16
 TOT.         31.63             6.64         8.80          3.87            4.31          26.41         -4.63

   PERCENT OF WASTEWATER CONTROLLED=     91.83

   POTENTIAL DISPOSAL DAYS= 169

   PACK ON DECEMBER 31 = 0.24              CHANGE IN SNOW STORAGE=-0.48

   INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

   PERCENT OF MAXIMUM POND VOLUME REQUIRED = 100.00

   ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 37.21

   ESTIMATED LAKE EVAPORATION, INCHES = 40.74

   MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.38 OR 81.9 % OF ANNUAL
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                              ***** ANNUAL SUMMARY *****

              WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1963
----------------------------------------------------------------------------------------------------------
                 INFLOWS
       -----------------------------                               OUTFLOWS
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  ----------------------------------------
                                                         DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE  CHANGE IN VOL.
 JAN.      0.04           0.18              0.               0.0            0.00          0.0          0.23
 FEB.      0.0            0.05              1.               0.31           0.01          0.0         -0.27
 MAR.      0.08           0.41              1.               0.46           0.03          0.0         -0.00
 APR.      0.09           0.13              0.               0.0            0.04          0.0          0.18
 MAY       0.04           0.0               1.               0.15           0.07          0.0         -0.18
 JUNE      0.12           0.18              1.               0.13           0.13          0.0          0.04
 JULY      0.19           1.11              3.               1.19           0.15          0.0         -0.03
 AUG.      0.13           0.60              2.               0.69           0.05          0.0         -0.01
 SEPT      0.24           1.24              3.               0.65           0.08          0.0          0.54
 OCT.      0.08           0.28              1.               0.50           0.07          0.0         -0.21
 NOV.      0.00           0.0               1.               0.33           0.01          0.0         -0.33
 DEC.      0.01           0.00              0.               0.0            0.00          0.0          0.02
 TOT.      1.03           4.21             14.               4.62           0.65          0.0         -0.03
                              WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1963
----------------------------------------------------------------------------------------------------------
                  INPUTS                                       OUTPUTS
        ---------------------------   ------------------------------------------------
MONTH   PRECIPITATION   IRRIGATION    INTERCEPTION  SURFACE RUNOFF  PERCOLATION    AET    CHANGE IN SM
 JAN.       1.12           0.0            0.15          0.00            0.0        0.16       0.45
 FEB.       0.0            0.31           0.24          0.01            0.0        0.78      -0.11
 MAR.       2.04           0.46           0.74          0.14            0.0        1.35       0.28
 APR.       2.27           0.0            0.60          0.19            0.0        0.74       0.75
 MAY        1.02           0.15           0.68          0.0             0.0        1.66      -1.17
 JUNE       3.07           0.13           0.94          0.0             0.0        3.35      -1.09
 JULY       4.96           1.19           1.02          0.17            0.0        5.14      -0.17
 AUG.       3.37           0.69           0.62          0.05            0.0        3.94      -0.55
 SEPT       6.05           0.85           1.00          0.95            0.0        2.69       2.27
 OCT.       1.92           0.50           0.30          0.55            0.0        1.11       0.47
 NOV.       0.07           0.33           0.17          0.0             0.0        0.86      -0.63
 DEC.       0.34           0.0            0.10          0.0             0.0        0.25      -0.11
 TOT.      26.23           4.62           6.55          2.05            0.0       22.02       0.37
PERCENT OF WASTEWATER CONTROLLED=     100.00

POTENTIAL DISPOSAL DAYS= 198

PACK ON DECEMBER 31 = 0.10               CHANGE IN SNOW STORAGE=-0.14

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED =  49.05

ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 38.17

ESTIMATED LAKE EVAPORATION, INCHES = 42.08

MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.94 OR 80.6 % OF ANNUAL
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                                   ***** ANNUAL SUMMARY *****

                    WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1964
----------------------------------------------------------------------------------------------------------------
                 INFLOWS
       ------------------------------                         OUTFLOWS
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  ---------------------------------------
                                                         DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE  CHANGE IN VOL.
 JAN.      0.00           0.00              0.               0.0            0.01          0.0         -0.01
 FEB.      0.02           0.0               0.               0.0            0.01          0.0          0.01
 MAR.      0.04           0.11              0.               0.0            0.04          0.0          0.11
 APR.      0.13           0.25              2.               0.35           0.06          0.0         -0.02
 MAY       0.05           0.0               0.               0.0            0.16          0.0         -0.11
 JUNE      0.18           0.72              2.               0.77           0.14          0.0         -0.01
 JULY      0.08           0.30              1.               0.33           0.04          0.0          0.01
 AUG.      0.14           0.25              1.               0.27           0.10          0.0          0.02
 SEPT      0.11           0.22              1.               0.27           0.09          0.0         -0.03
 OCT.      0.01           0.0               0.               0.0            0.01          0.0         -0.00
 NOV.      0.03           0.00              0.               0.0            0.01          0.0          0.02
 DEC.      0.02           0.07              0.               0.0            0.00          0.0          0.08
 TOT.      0.82           1.93              7.               1.98           0.67          0.0          0.09
                          WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1964
----------------------------------------------------------------------------------------------------------------
              INPUTS
       --------------------------                        OUTPUTS
MONTH  PRECIPITATION  IRRIGATION  ------------------------------------------------------
                                  INTERCEPTION  SURFACE RUNOFF  PERCOLATION   AET   CHANGE IN SM
 JAN.      0.02           0.0         0.12           0.0            0.0       0.31     -0.31
 FEB.      0.57           0.0         0.22           0.0            0.0       0.20      0.14
 MAR.      1.05           0.0         0.32           0.0            0.0       0.34      0.39
 APR.      3.27           0.35        0.90           0.39           0.0       1.49      0.83
 MAY       1.33           0.0         0.58           0.00           0.0       1.79     -1.04
 JUNE      4.63           0.77        1.11           0.60           0.0       3.48      0.21
 JULY      2.00           0.33        0.40           0.0            0.0       4.68     -2.74
 AUG.      3.55           0.27        1.05           0.0            0.0       2.19      0.57
 SEPT      2.79           0.27        0.85           0.0            0.0       2.44     -0.23
 OCT.      0.31           0.0         0.15           0.0            0.0       0.72     -0.56
 NOV.      0.86           0.0         0.29           0.0            0.0       0.55      0.02
 DEC.      0.42           0.0         0.10           0.0            0.0       0.24      0.08
 TOT.     20.80           1.98        6.10           0.99           0.0      18.43     -2.63
PERCENT OF WASTEWATER CONTROLLED=    100.00

POTENTIAL DISPOSAL DAYS= 235

PACK ON DECEMBER 31 = 0.0                  CHANGE IN SNOW STORAGE=-0.10

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED =  32.03

ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 37.73

ESTIMATED LAKE EVAPORATION, INCHES = 40.17

MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.35 OR 83.0 % CF ANNUAL
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                              ***** ANNUAL SUMMARY *****

              WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1965

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                   INFLOWS                                                    OUTFLOWS
        -----------------------------                         --------------------------------------
MONTH   PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE    CHANGE IN VOL.
 JAN.        0.03          0.02                1.               0.13           0.00          0.0          -0.08
 FEB.        0.12          1.52                1.               0.30           0.00          0.0           1.34
 MAR.        0.07          0.18                0.               0.0            0.00          0.0           0.24
 APR.        0.05          0.11                4.               1.67           0.10          0.0          -1.61
 MAY         0.18          1.01                1.               0.50           0.16          0.0           0.53
 JUNE        0.30          1.30                3.               1.05           0.13          0.0           0.42
 JULY        0.21          1.53                3.               1.48           0.12          0.0           0.14
 AUG.        0.14          0.95                4.               1.97           0.15          0.0          -1.03
 SEPT        0.17          0.62                2.               0.60           0.06          0.0           0.13
 OCT.        0.01          0.0                 1.               0.16           0.03          0.0          -0.19
 NOV.        0.00          0.0                 0.               0.0            0.00          0.0           0.00
 DEC.        0.02          0.0                 0.               0.0            0.01          0.0           0.01
 TOT.        1.30          7.25               20.               7.86           0.77          0.0          -0.09
                         WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1965
-------------------------------------------------------------------------------------------------------
                    INPUTS                                         OUTPUTS
           ---------------------------  --------------------------------------------------------
MONTH      PRECIPITATION    IRRIGATION  INTERCEPTION  SURFACE RUNOFF  PERCOLATION      AET       CHANGE IN SM
 JAN.           0.82           0.13         0.21           0.0            0.0          0.18         -0.01
 FEB.           3.14           0.30         0.37           0.0            0.0          0.23          1.50
 MAR.           1.66           0.0          0.45           0.10           0.0          0.51          2.51
 APR.           1.16           1.67         0.73           0.17           0.0          2.11         -0.18
 MAY            4.56           0.50         0.80           0.99           0.0          1.82          1.45
 JUNE           7.73           1.05         1.41           2.09           0.0          3.62          1.66
 JULY           5.42           1.48         1.34           0.52           0.0          6.47         -1.42
 AUG.           3.47           1.97         0.78           0.45           0.0          6.08         -1.87
 SEPT           4.25           0.60         0.85           0.70           0.0          3.16          0.14
 OCT.           0.20           0.16         0.20           0.0            0.0          1.06         -0.90
 NOV.           0.09           0.0          0.09           0.0            0.0          0.75         -0.75
 DEC.           0.50           0.0          0.19           0.0            0.0          0.25          0.06
 TOT.          33.00           7.86         7.42           5.02           0.0         26.22          2.20
  PERCENT OF WASTEWATER CONTROLLED=    100.00

  POTENTIAL DISPOSAL DAYS= 153

  PACK ON DECEMBER 31 = 0.0                 CHANGE IN SNOW STORAGE= 0.0

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  68.74

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 35.23

  ESTIMATED LAKE EVAPORATION, INCHES = 38.45

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.57 OR 84.7 % OF ANNUAL
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                              ***** ANNUAL SUMMARY *****

            WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1966
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              INFLOWS                                               OUTFLOWS
       ------------------------------                   ---------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.      0.00           0.0                0.              0.0            0.00          0.0          0.00
 FEB.      0.07           0.50               1.              0.50           0.01          0.0          0.06
 MAR.      0.01           0.0                0.              0.0            0.07          0.0         -0.06
 APR.      0.03           0.0                0.              0.0            0.03          0.0         -0.00
 MAY       0.01           0.0                0.              0.0            0.02          0.0         -0.01
 JUNE      0.14           0.79               2.              0.81           0.09          0.0          0.03
 JULY      0.14           0.47               1.              0.50           0.13          0.0         -0.02
 AUG.      0.15           0.91               4.              1.03           0.03          0.0         -0.00
 SEPT      0.11           0.60               2.              0.65           0.06          0.0          0.01
 OCT.      0.03           0.0                0.              0.0            0.04          0.0         -0.00
 NOV.      0.00           0.00               0.              0.0            0.00          0.0         -0.00
 DEC.      0.05           0.0                0.              0.0            0.00          0.0          0.05
 TOT.      0.75           3.26              10.              3.49           0.49          0.0          0.04

                         WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1966
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                 INPUTS                                       OUTPUTS
         ---------------------------     ----------------------------------------------------
MONTH    PRECIPITATION    IRRIGATION     INTERCEPTION  SURFACE RUNOFF  PERCOLATION      AET       CHANGE IN SM
 JAN.        0.11            0.0             0.09          0.0            0.0           0.15         -0.13
 FEB.        1.86            0.50            0.20          0.22           0.0           0.51          0.92
 MAR.        0.22            0.0             0.24          0.0            0.0           0.99         -0.51
 APR.        0.75            0.0             0.37          0.0            0.0           0.46         -0.08
 MAY         0.16            0.0             0.14          0.0            0.0           1.47         -1.45
 JUNE        3.45            0.81            0.67          0.03           0.0           2.74          0.[illegible]1
 JULY        3.51            0.50            0.85          0.0            0.0           4.06         -0.90
 AUG.        3.83            1.03            0.80          0.04           0.0           3.94          0.08
 SEPT        2.90            0.65            0.67          0.44           0.0           2.50         -0.06
 OCT.        0.84            0.0             0.16          0.0            0.0           0.79         -0.11
 NOV.        0.07            0.0             0.07          0.0            0.0           0.62         -0.62
 DEC.        1.29            0.0             0.02          0.0            0.0           0.27         -0.27
 TOT.       18.99            3.49            4.28          0.74           0.0          18.51         -2.32

 PERCENT OF WASTEWATER CONTROLLED=    100.00

 POTENTIAL DISPOSAL DAYS= 251

 PACK ON DECEMBER 31 = 1.27              CHANGE IN SNOW STORAGE= 1.27

 INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

 PERCENT OF MAXIMUM POND VOLUME REQUIRED =  33.85

 ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 37.36

 ESTIMATED LAKE EVAPORATION, INCHES = 40.59

 MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.18 OR 81.7 % OF ANNUAL
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                          ***** ANNUAL SUMMARY *****

        WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1967
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                  INFLOWS                                                OUTFLOWS
         ----------------------------                   ----------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE  CHANGE IN VOL.
 JAN.       0.01          0.54               1.               0.50           0.00        0.0          0.05
 FEB.       0.01          0.00               0.               0.0            0.01        0.0         -0.0C
 MAR.       0.04          0.0                0.               0.0            0.08        0.0         -0.04
 APR.       0.16          0.55               2.               0.69           0.08        0.0         -0.06
 MAY        0.10          0.04               0.               0.0            0.12        0.0          0.02
 JUNE       0.39          2.36               3.               1.50           0.22        0.0          1.03
 JULY       0.13          0.26               3.               1.24           0.13        0.0         -0.99
 AUG.       0.10          0.62               2.               0.69           0.09        0.0         -0.06
 SEPT       0.26          1.50               2.               0.84           0.09        0.0          0.83
 OCT.       0.05          0.0                1.               0.50           0.08        0.0         -0.53
 NOV.       0.02          0.0                1.               0.30           0.01        0.0         -0.29
 DEC.       0.06          0.07               0.               0.0            0.01        0.0          0.12
 TOT.       1.33          5.93              15.               6.27           0.92        0.0          0.08

                     WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1967
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                  INPUTS                                  OUTPUTS
        -----------------------------   ------------------------------------------------------
MONTH   PRECIPITATION   IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCULATION      AET      CHANGE IN SM
 JAN.       0.35           0.50          0.23          0.0            0.0           0.30         1.59
 FEB.       0.25           0.0           0.20          0.0            0.0           0.20        -0.15
 MAR.       1.02           0.0           0.17          0.0            0.0           0.54         0.12
 APR.       4.19           0.69          1.08          0.87           0.0           1.97         0.97
 MAY        2.52           0.0           0.97          0.01           0.0           1.45         0.09
 JUNE       9.82           1.50          1.29          3.46           0.0           3.44         3.13
 JULY       3.29           1.24          1.13          0.08           0.0           6.22        -2.90
 AUG.       2.65           0.69          0.76          0.03           0.0           4.95        -2.40
 SEPT       6.57           0.84          1.20          0.78           0.0           2.39         3.05
 OCT.       1.18           0.50          0.60          0.03           0.0           0.89         0.16
 NOV.       0.40           0.30          0.28          0.00           0.0           0.79        -0.37
 DEC.       1.61           0.0           0.25          0.0            0.0           0.35         0.61
 TOT.      33.85           6.27          8.35          5.24           0.0          23.49         3.91

 PERCENT OF WASTEWATER CONTROLLED=    100.00

 POTENTIAL DISPOSAL DAYS= 166

 PACK ON DECEMBER 31 = 0.40              CHANGE IN SNOW STORAGE=-0.87

 INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

 PERCENT OF MAXIMUM POND VOLUME REQUIRED =  65.12

 ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 36.37

 ESTIMATED LAKE EVAPORATION, INCHES = 39.66

 MAY - OCTOBER LAKE EVAPORATION, INCHES = 31.40 OR 79.2 % CF ANNUAL
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***** ANNUAL SUMMARY *****

WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1968

	INFLOWS			OUTFLOWS			
MONTH	PRECIPITATION	FEEDLOT RUNOFF	NO. DISPOSAL DAYS	DISPOSAL VOL.	SURFACE EVAP.	DISCHARGE	CHANGE IN VOL.
JAN.	0.01	0.12	0.	0.0	0.00	0.0	0.12
FEB.	0.02	0.0	1.	0.25	0.0	0.0	-0.23
MAR.	0.00	0.12	1.	0.14	0.01	0.0	-0.02
APR.	0.15	0.39	2.	0.47	0.06	0.0	-0.00
MAY	0.10	0.02	0.	0.0	0.11	0.0	0.01
JUNE	0.17	1.14	3.	1.22	0.10	0.0	-0.01
JULY	0.18	0.74	2.	0.77	0.09	0.0	0.06
AUG.	0.37	2.30	5.	1.71	0.11	0.0	0.85
SEPT	0.17	0.92	4.	1.89	0.12	0.0	-0.91
OCT.	0.12	0.79	1.	0.50	0.05	0.0	0.35
NOV.	0.04	0.19	1.	0.50	0.02	0.0	-0.29
DEC.	0.07	0.0	0.	0.0	0.01	0.0	0.06
TOT.	1.40	6.73	20.	7.45	0.68	0.0	0.00

WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1968

	INPUTS		OUTPUTS				
MONTH	PRECIPITATION	IRRIGATION	INTERCEPTION	SURFACE RUNOFF	PERCOLATION	AET	CHANGE IN SM
JAN.	0.14	0.0	0.16	0.0	0.0	0.31	0.08
FEB.	0.56	0.25	0.29	0.0	0.0	0.57	-0.05
MAR.	0.06	0.14	0.13	0.0	0.0	0.99	-0.92
APR.	3.83	0.47	0.99	0.15	0.0	1.87	1.29
MAY	2.51	0.0	0.91	0.07	0.0	1.63	-0.10
JUNE	4.31	1.22	0.71	1.81	0.0	3.77	-0.76
JULY	4.59	0.77	1.01	0.00	0.0	4.93	-0.59
AUG.	9.40	1.71	1.43	2.54	0.0	5.67	1.47
SEPT	4.43	1.89	0.90	1.33	0.0	3.37	0.71
OCT.	2.97	0.50	0.39	1.02	0.0	1.04	1.02
NOV.	1.07	0.50	0.51	0.12	0.0	0.43	0.52
DEC.	1.74	0.0	0.10	0.0	0.0	0.23	-0.07
TOT.	35.61	7.45	7.52	7.04	0.0	24.82	2.61

PERCENT OF WASTEWATER CONTROLLED= 100.00

POTENTIAL DISPOSAL DAYS= 134

PACK ON DECEMBER 31 = 1.47 CHANGE IN SNOW STORAGE= 1.07

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED = 36.16

ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 37.04

ESTIMATED LAKE EVAPORATION, INCHES = 39.92

MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.54 OR 81.5 % OF ANNUAL

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                              ***** ANNUAL SUMMARY *****

              WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1969
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                  INFLOWS                                            OUTFLOWS
         ----------------------------                 ------------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VCL.
 JAN.       0.02          0.62               0.             0.0            0.00          0.0           0.65
 FEB.       0.06          0.0                0.             0.0            0.0           0.0           0.06
 MAR.       0.09          1.37               1.             0.50           0.03          0.0           0.92
 APR.       0.10          0.54               5.             2.20           0.13          0.0          -1.69
 MAY        0.26          1.11               0.             0.0            0.19          0.0           1.18
 JUNE       0.09          0.20               4.             1.39           0.15          0.0          -1.25
 JULY       0.38          2.53               6.             2.78           0.13          0.0          -0.00
 AUG.       0.06          0.0                0.             0.0            0.05          0.0           0.01
 SEPT       0.06          0.10               1.             0.14           0.03          0.0          -0.01
 OCT.       0.15          0.33               2.             0.29           0.04          0.0           0.15
 NOV.       0.00          0.0                1.             0.14           0.01          0.0          -0.15
 DEC.       0.02          0.04               0.             0.0            0.00          0.0           0.06
 TOT.       1.30          6.84              20.             7.44           0.76          0.0          -0.07
                          WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1969
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                  INPUTS                                   OUTPUTS
          --------------------------   ------------------------------------------------------
MONTH    PRECIPITATION   IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCULATION     AET      CHANGE IN SM
 JAN.        0.59           0.0           0.19          0.02            0.0          0.26        0.51
 FEB.        1.54           0.0           0.37          0.00            0.45         0.39        0.22
 MAR.        2.29           0.50          0.50          0.89            1.99         0.85       -0.26
 APR.        2.65           2.20          0.97          0.88            1.28         1.90       -0.18
 MAY         6.55           0.0           1.08          1.42            1.70         1.73        0.63
 JUNE        2.35           1.39          1.02          0.38            0.16         3.54       -1.35
 JULY        9.63           2.78          1.33          3.82            0.16         6.58        0.52
 AUG.        1.54           0.0           0.64          0.03            0.0          6.01       -5.13
 SEPT        1.59           0.14          0.42          0.0             0.0          2.18       -0.87
 OCT.        3.71           0.29          1.00          0.01            0.0          0.40        2.58
 NOV.        0.05           0.14          0.15          0.0             0.0          0.81       -0.77
 DEC.        0.62           0.0           0.21          0.0             0.0          0.28       -0.11
 TOT.       33.11           7.44          7.89          7.45            5.73        24.90       -4.21
 PERCENT OF WASTEWATER CONTROLLED=    100.00

 POTENTIAL DISPOSAL DAYS= 153

 PACK ON DECEMBER 31 = 0.25              CHANGE IN SNOW STORAGE=-1.22

 INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

 PERCENT OF MAXIMUM POND VOLUME REQUIRED =  70.25

 ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 35.26

 ESTIMATED LAKE EVAPORATION, INCHES = 38.74

 MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.42 OR 83.7 % CF ANNUAL
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                                ***** ANNUAL SUMMARY *****

                WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1970
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                  INFLOWS                                                  OUTFLOWS
       ------------------------------                  ---------------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE  CHANGE IN VOL.
 JAN.      0.00           0.05              0.               0.0            0.01         0.0          0.05
 FEB.      0.00           0.0               0.               0.0            0.03         0.0         -0.02
 MAR.      0.05           0.01              0.               0.0            0.03         0.0          0.02
 APR.      0.11           0.40              2.               0.58           0.04         0.0         -0.11
 MAY       0.16           0.67              0.               0.0            0.08         0.0          0.74
 JUNE      0.18           0.99              4.               1.77           0.14         0.0         -0.74
 JULY      0.04           0.05              0.               0.0            0.09         0.0         -0.00
 AUG.      0.09           0.54              1.               0.50           0.09         0.0          0.04
 SEPT      0.30           1.99              4.               2.00           0.14         0.0          0.15
 OCT.      0.08           0.36              2.               0.57           0.05         0.0         -0.19
 NOV.      0.04           0.09              0.               0.0            0.01         0.0          0.11
 DEC.      0.01           0.0               0.               0.0            0.01         0.0          0.00
 TOT.      1.06           5.15             13.               5.43           0.73         0.0          0.06
                          WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1970
--------------------------------------------------------------------------------------------------------------
                   INPUTS                                      OUTPUTS
          ---------------------------   -----------------------------------------------------
MONTH     PRECIPITATION   IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCOLATION     AET      CHANGE IN SM
 JAN.         0.11           0.0           0.10           0.0            0.0         0.25         0.01
 FEB.         0.05           0.0           0.05           0.0            0.0         0.31        -0.31
 MAR.         1.24           0.0           0.49           0.0            0.0         0.22         0.30
 APR.         2.86           0.58          0.69           0.48           0.0         1.68         0.82
 MAY          4.00           0.0           0.81           0.59           0.0         1.77         0.83
 JUNE         4.67           1.77          1.02           1.80           0.0         3.75        -0.13
 JULY         1.00           0.0           0.29           0.0            0.0         4.13        -3.42
 AUG.         2.31           0.50          0.40           0.02           0.0         2.28         0.11
 SEPT         7.62           2.00          1.23           1.32           0.0         2.99         4.08
 OCT.         1.98           0.57          0.55           0.59           0.0         0.85         0.55
 NOV.         0.97           0.0           0.22           0.13           0.0         0.75        -0.13
 DEC.         0.25           0.0           0.02           0.0            0.0         0.59        -0.45
 TOT.        27.06           5.43          5.88           4.93           0.0        19.58         2.27
  PERCENT OF WASTEWATER CONTROLLED=     100.00

  POTENTIAL DISPOSAL DAYS= 168

  PACK ON DECEMBER 31 = 0.08              CHANGE IN SNOW STORAGE=-0.17

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  62.38

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 37.71

  ESTIMATED LAKE EVAPORATION, INCHES = 40.41

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.58 OR 83.1 % OF ANNUAL
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                                         ***** ANNUAL SUMMARY *****
            5/22/71  -  DISCHARGE OF        31.20 ACRE-IN

                  WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1971

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                 INFLOWS                                                    OUTFLOWS
        -----------------------------                     -------------------------------------------
MONTH   PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.       0.05           0.0                0.               0.0            0.0          0.0          0.05
 FEB.       0.12           0.92               0.               0.0            0.01         0.0          1.02
 MAR.       0.05           0.90               2.               1.00           0.05         0.0         -0.10
 APR.       0.04           0.0                2.               1.00           0.12         0.0         -1.08
 MAY        0.36           2.75               1.               0.50           0.14         0.39         2.07
 JUNE       0.13           0.65               5.               2.50           0.24         0.0         -1.96
 JULY       0.22           1.16               3.               1.35           0.16         0.0         -0.12
 AUG.       0.03           0.03               0.               0.0            0.06         0.0          0.00
 SEPT       0.05           0.02               0.               0.0            0.07         0.0          0.00
 OCT.       0.22           1.46               0.               0.0            0.04         0.0          1.64
 NOV.       0.12           0.65               1.               0.50           0.03         0.0          0.24
 DEC.       0.04           0.20               0.               0.0            0.00         0.0          0.24
 TOT.       1.42           8.75              14.               6.85           0.92         0.39         2.01

                      WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1971
--------------------------------------------------------------------------------------------------------------
                        INPUTS                                   OUTPUTS
            ---------------------------   ----------------------------------------------------------
MONTH       PRECIPITATION    IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCOLATION      AET     CHANGE IN SM
 JAN.           1.33            0.0           0.31           0.0           0.0          0.24         0.79
 FEB.           2.93            0.0           0.36           0.13          0.0          0.34         0.73
 MAR.           1.19            1.00          0.56           0.16          0.59         0.98         0.85
 APR.           0.90            1.00          0.71           0.0           0.23         1.75        -0.29
 MAY            9.06            0.50          0.99           3.04          2.83         1.66         1.04
 JUNE           3.31            2.50          1.07           0.80          1.26         3.86        -1.18
 JULY           5.60            1.35          1.42           1.55          0.12         6.22        -2.37
 AUG.           0.85            0.0           0.32           0.0           0.0          4.03        -3.50
 SEPT           1.20            0.0           0.33           0.0           0.0          1.16        -0.29
 OCT.           5.58            0.0           0.46           0.86          0.0          0.53         3.73
 NOV.           3.02            0.50          0.49           0.84          0.0          0.54         1.48
 DEC.           1.07            0.0           0.28           0.16          0.0          0.44         0.37
 TOT.          36.04            6.85          7.30           7.54          5.02        21.76         1.34

  PERCENT OF WASTEWATER CONTROLLED=     96.16

  POTENTIAL DISPOSAL DAYS= 133

  PACK ON DECEMBER 31 = 0.0               CHANGE IN SNOW STORAGE=-0.08

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED = 100.00

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 36.09

  ESTIMATED LAKE EVAPORATION, INCHES = 39.22

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.66 OR 83.3 % OF ANNUAL
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                              ***** ANNUAL SUMMARY *****

               WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1972
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                    INFLOWS                                               OUTFLOWS
         ------------------------------                    --------------------------------------
MONTH    PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.        0.01           0.29                0.              0.0            0.00          0.0          0.29
 FEB.        0.02           0.08                2.              1.00           0.02          0.0         -0.92
 MAR.        0.02           0.0                 3.              1.46           0.06          0.0         -1.50
 APR.        0.12           0.46                1.              0.50           0.05          0.0          0.02
 MAY         0.28           1.29                1.              0.50           0.19          0.0          0.89
 JUNE        0.10           0.77                4.              1.68           0.10          0.0         -0.91
 JULY        0.16           0.44                2.              0.48           0.12          0.0         -0.00
 AUG.        0.31           2.19                3.              1.48           0.09          0.0          0.94
 SEPT        0.07           0.11                2.              0.99           0.09          0.0         -0.90
 OCT.        0.10           0.38                0.              0.0            0.07          0.0          0.41
 NOV.        0.16           0.85                0.              0.0            0.02          0.0          1.00
 DEC.        0.05           0.53                0.              0.0            0.01          0.0          0.57
 TOT.        1.41           7.40               18.              8.09           0.82          0.0         -0.10
                          WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1972
------------------------------------------------------------------------------------------------------
                  INPUTS                                        OUTPUTS
         ---------------------------     ------------------------------------------------------
MONTH    PRECIPITATION   IRRIGATION     INTERCEPTION  SURFACE RUNOFF   PERCOLATION        AET     CHANGE IN SM
 JAN.        0.17           0.0             0.12           0.0             0.0            0.27       -0.23
 FEB.        0.44           1.00            0.23           0.01            0.0            0.64        0.08
 MAR.        0.52           1.46            0.62           0.01            0.0            1.82        0.03
 APR.        2.96           0.50            0.52           0.33            0.0            1.10        1.01
 MAY         7.18           0.50            1.21           2.38            2.53           1.72        0.35
 JUNE        2.64           1.68            0.70           0.54            0.47           3.77       -1.16
 JULY        4.02           0.48            1.05           0.00            0.0            6.32       -2.87
 AUG.        7.88           1.48            1.11           1.50            0.0            5.76        0.98
 SEPT        1.85           0.99            0.60           0.12            0.0            3.37       -1.24
 OCT.        2.64           0.0             0.61           0.18            0.0            0.82        1.03
 NOV.        4.19           0.0             0.56           0.91            0.0            0.40        2.31
 DEC.        1.33           0.0             0.22           0.00            0.0            0.14        0.34
 TOT.       35.82           8.09            7.55           5.99            3.00          26.12        0.63
 PERCENT OF WASTEWATER CONTROLLED=    100.00

 POTENTIAL DISPOSAL DAYS= 147

 PACK ON DECEMBER 31 = 0.63                CHANGE IN SNOW STORAGE= 0.63

 INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

 PERCENT OF MAXIMUM POND VOLUME REQUIRED =  99.43

 ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 36.48

 ESTIMATED LAKE EVAPORATION, INCHES = 40.10

 MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.28 OR 80.5 % OF ANNUAL
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                                      ***** ANNUAL SUMMARY *****
 3/30/73  -  DISCHARGE OF        6.88 ACRE-IN
 9/28/73  -  DISCHARGE OF        9.59 ACRE-IN
10/11/73  -  DISCHARGE OF      138.28 ACRE-IN

          WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1973
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                 INFLOWS                                                 OUTFLCWS
       ---------------------------                        ---------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VCL.
 JAN.      0.05           0.03               0.              0.0            0.01         0.0          0.07
 FEB.      0.02           0.08               1.              0.50           0.02         0.0         -0.42
 MAR.      0.27           1.27               1.              0.50           0.10         0.09         0.85
 APR.      0.10           0.20               5.              2.50           0.13         0.0         -2.33
 MAY       0.18           0.79               2.              0.98           0.15         0.0         -0.16
 JUNE      0.07           0.18               1.              0.24           0.05         0.0         -0.04
 JULY      0.34           2.40               5.              2.48           0.20         0.0          0.06
 AUG.      0.07           0.02               0.              0.0            0.15         0.0         -0.06
 SEPT      0.44           3.24               2.              0.93           0.11         0.12         2.52
 OCT.      0.21           2.07               2.              1.00           0.10         1.73        -0.55
 NOV.      0.04           0.05               2.              1.00           0.04         0.0         -0.95
 DEC.      0.11           0.22               0.              0.0            0.00         0.0          0.34
 TOT.      1.90          10.55              21.             10.13           1.05         1.93        -0.66
                WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1973
------------------------------------------------------------------------------------------------------------
                    INPUTS                                       OUTPUTS
        -----------------------------  --------------------------------------------------------------
MONTH   PRECIPITATION    IRRIGATION    INTERCEPTION  SURFACE RUNOFF  PERCULATION      AET      CHANGE IN SM
 JAN.       1.29            0.0            0.43           0.06           0.31         0.22         0.73
 FEB.       0.55            0.50           0.30           0.01           0.52         0.45        -0.06
 MAR.       6.76            0.50           1.27           1.74           3.04         1.18         0.03
 APR.       2.64            2.50           1.13           0.75           1.13         2.17        -0.05
 MAY        4.67            0.98           0.98           1.13           1.96         1.68        -0.10
 JUNE       1.77            0.24           0.64           0.18           0.23         3.83        -2.94
 JULY       8.60            2.48           1.04           1.81           0.0          6.44         1.78
 AUG.       1.67            0.0            0.57           0.0            0.0          5.78        -4.68
 SEPT      11.14            0.93           1.48           3.39           0.0          2.68         4.52
 OCT.       5.41            1.00           0.55           3.29           0.35         1.00         1.22
 NOV.       1.05            1.00           0.43           0.08           0.77         0.64         0.13
 DEC.       2.92            0.0            0.16           0.00           0.20         0.34         0.11
 TOT.      48.47           10.13           8.98          12.46           8.56        26.43         0.70
 PERCENT CF WASTEWATER CONTROLLED=      84.47

 POTENTIAL DISPOSAL DAYS=  96

 PACK ON DECEMBER 31 = 2.10              CHANGE IN SNOW SICRAGE= 1.48

 INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

 PERCENT OF MAXIMUM POND VCLUME REQUIRED = 100.00

 ESTIMATED POTENTIAL EVAPCTRANSPIRATICN, INCHES = 36.80

 ESTIMATED LAKE EVAPORATION, INCHES = 41.08

 MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.71 OR 79.6 % CF ANNUAL
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STATION:   BELLEVILLE, KANSAS          1949  TO  1973

CRITICAL EVENT- 5.10 INCHES


FEEDLOT AREA- 40.00 ACRES


POND VARIABLES:

             (A) BASE DIMENSION-- 570.00  FEET BY  190.00  FEET

             (B) SIDF SLOPE--   RUN: RISE = 3.0 : 1

             (C) MAXIMUM DEPTH--   6.00  FEET

             (D) MAXIPUM POND VOLUME--     202.33 ACRE-INCHES

             (E) DIRECT RECEIVING AREA (FOR PRECIPITATICN) --      3.14 ACRES

DISPOSAL AREA VARIABLES:

             (A) DISPOSAL AREA--    80.00  ACRES

             (B) CROP--  CORN

             (C) SOIL TYPE--    5   (SCS) SOIL TYPE

             (D) DISPOSAL RATE--   0.50  INCHES/DAY ON DISPOSAL DAYS

             (E) IRRIGATION MANAGEMENT--   IRRIGATICN BELOW   0.90  AVAILABLE MOISTURE


                              ***** FINAL SUMMARY *****
METEOROLOGICAL SUMMARY

             AVERAGE ANNUAL LAKE EVAPORATION= 40.55 INCFES

             AVERAGE MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.24 OR 82.0 % OF ANNUAL
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          AVERAGE ANNUAL PRECIPITATION= 30.03 INCHES
          AVERAGE ANNUAL POTENTIAL EVAPOTRANSPIRATION= 37.12 INCHES
          PRECIPITATION RANGE= 32.57 INCHES   (FROM A LOW OF 15.90 INCHES  TO A HIGH OF  48.47 INCHES)
SUMMARY OF POND OPERATIONS
          NO. OF YEARS HAVING A DISCHARGE=     6
          AVERAGE NO. OF DISCHARGES / YEAR HAVING A DISCHARGE=  1.83
          AVERAGE DISCHARGE= 38.12 ACRE-INCHES
          AVERAGE PERCENT OF WASTEWATER CONTROLLED= 97.96
          TOTAL DISCHARGE VOLUME=   419.30 ACRE-INCHES
          TOTAL NO. OF DISCHARGES= 11.
          MAXIMUM DISCHARGE=138.28 ACRE-INCHES
SUMMARY OF DISPOSAL AREA
          AVERAGE ANNUAL DEPTH OF WASTEWATER APPLIED=  5.72 INCHES OVER ENTIRE DISPOSAL AREA
          AVERAGE ANNUAL DISPOSAL AREA RUNOFF=  4.65 INCHES
          AVERAGE ANNUAL DISPOSAL AREA PERCOLATION=  1.42 INCHES
          AVERAGE ANNUAL NO. OF DISPOSAL DAYS=  14.6
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STATION:   BELLEVILLE, KANSAS          1949  TO  1973


CRITICAL EVENT- 5.10 INCHES


FEEDLOT AREA- 40.00 ACRES


POND VARIABLES:

               (A) BASE DIMENSION-- 700.00  FEET BY 2800.00  FEET

               (B) SIDE SLOPE--   RUN: RISE = 3.0 : 1

               (C) MAXIMUM DEPTH--   6.00  FEET

               (D) MAXIMUM POND VOLUME--    3344.52 ACRE-INCHES

               (E) DIRECT RECEIVING AREA (FOR PRECIPITATION) --     47.92 ACRES


DISPOSAL AREA VARIABLES:

               (A) DISPOSAL AREA--    80.00  ACRES

               (B) CROP--  CORN

               (C) SOIL TYPE--    5   (SCS) SOIL TYPE

               (D) DISPOSAL RATE--   0.50  INCHES/DAY ON DISPOSAL DAYS

               (E) IRRIGATION MANAGEMENT--   IRRIGATICN BELOW   0.0   AVAILABLE MOISTURE
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                               ***** ANNUAL SUMMARY *****

             WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1949
------------------------------------------------------------------------------------------------------
                  INFLOWS                                                OUTFLOWS
        ------------------------------                   ------------------------------------------
MONTH   PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE    CHANGE IN VCL.
 JAN.       1.33           0.0               0.              0.0            0.0          0.0            1.33
 FEB.       0.35           1.20              0.              0.0            0.03         0.0            1.51
 MAR.       0.81           0.07              0.              0.0            0.89         0.0           -0.00
 APR.       1.07           0.11              0.              0.0            2.33         0.0           -1.16
 MAY        2.92           0.62              0.              0.0            3.31         0.0            0.23
 JUNE       3.98           1.23              0.              0.0            3.87         0.0            1.35
 JULY       2.73           1.00              0.              0.0            4.33         0.0           -0.60
 AUG.       2.55           0.85              0.              0.0            3.59         0.0           -0.19
 SEPT       1.86           0.16              0.              0.0            2.32         0.0           -0.31
 OCT.       1.21           0.38              0.              0.0            1.51         0.0            0.08
 NOV.       0.0            0.0               0.              0.0            0.73         0.0           -0.73
 DEC.       0.37           0.01              0.              0.0            0.11         0.0            0.27
 TOT.      19.18           5.63              0.              0.0           23.02         0.0            1.79
                        WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1949
------------------------------------------------------------------------------------------------------
                     INPUTS                                       OUTPUTS
          ----------------------------   ------------------------------------------------------
MONTH     PRECIPITATION    IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCOLATION      AET       CHANGE IN SM
 JAN.         2.22            0.0           0.20           0.0            0.0          0.17          0.18
 FEB.         0.58            0.0           0.29           0.02           0.0          0.32          1.29
 MAR.         1.36            0.0           0.54           0.09           0.0          0.97          0.09
 APR.         1.78            0.0           0.51           0.01           0.0          1.89         -0.62
 MAY          4.88            0.0           1.09           0.51           0.0          1.82          1.46
 JUNE         6.65            0.0           0.97           1.64           0.0          3.81          0.22
 JULY         4.55            0.0           0.70           0.14           0.0          6.56         -2.85
 AUG.         4.26            0.0           0.61           0.14           0.0          5.11         -1.61
 SEPT         3.10            0.0           0.76           0.00           0.0          2.54         -0.20
 OCT.         2.02            0.0           0.43           0.00           0.0          0.83          0.76
 NOV.         0.0             0.0           0.0            0.0            0.0          0.80         -0.80
 DEC.         0.62            0.0           0.24           0.0            0.0          0.29          0.01
 TOT.        32.02            0.0           6.33           2.55           0.0         25.12         -2.08
   PERCENT OF WASTEWATER CONTROLLED=     100.00

   POTENTIAL DISPOSAL DAYS=   0

   PACK ON DECEMBER 31 = 0.08              CHANGE IN SNOW STORAGE= 0.08

   INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

   PERCENT OF MAXIMUM POND VOLUME REQUIRED =   8.73

   ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 36.88

   ESTIMATED LAKE EVAPORATION, INCHES = 40.78

   MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.53 OR 82.2 % OF ANNUAL
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                              ***** ANNUAL SUMMARY *****

          WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1950

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              INFLOWS                                                OUTFLOWS
       ----------------------------                   -------------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.      0.01           0.09              0.               0.0            0.11          0.0         -0.01
 FEB.      0.54           0.01              0.               0.0            0.21          0.0          0.34
 MAR.      0.29           0.11              0.               0.0            0.81          0.0         -0.41
 APR.      0.45           0.0               0.               0.0            2.07          0.0         -1.62
 MAY       2.96           0.89              0.               0.0            2.17          0.0          1.67
 JUNE      0.32           0.0               0.               0.0            2.07          0.0         -1.75
 JULY      3.31           0.82              0.               0.0            3.13          0.0          1.00
 AUG.      4.26           1.60              0.               0.0            3.33          0.0          2.53
 SEPT      2.76           1.59              0.               0.0            2.38          0.0          1.97
 OCT.      1.11           0.54              0.               0.0            1.58          0.0          0.07
 NOV.      0.31           0.0               0.               0.0            0.34          0.0         -0.04
 DEC.      0.19           0.03              0.               0.0            0.05          0.0          0.16
 TOT.     16.52           5.66              0.               0.0           18.27          0.0          3.91

                     WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1950
-----------------------------------------------------------------------------------------------------
                     INPUTS                                   OUTPUTS
         ----------------------------   ------------------------------------------------------
MONTH    PRECIPITATION    IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCULATION     AET     CHANGE IN SM
 JAN.        0.02            0.0           0.03          0.0            0.0          0.17       -0.12
 FEB.        0.90            0.0           0.42          0.0            0.0          0.18        0.32
 MAR.        0.49            0.0           0.44          0.0            0.0          0.18       -0.13
 APR.        0.75            0.0           0.40          0.0            0.0          0.22        0.13
 MAY         4.94            0.0           0.78          0.48           0.0          1.30        2.38
 JUNE        0.54            0.0           0.44          0.0            0.0          2.97       -2.87
 JULY        5.53            0.0           1.20          0.04           0.0          3.90        0.39
 AUG.        7.12            0.0           1.22          0.69           0.0          3.87        1.34
 SEPT        4.61            0.0           0.28          0.58           0.0          2.78        0.97
 OCT.        1.86            0.0           0.12          0.89           0.0          1.20       -0.35
 NOV.        0.51            0.0           0.14          0.0            0.0          0.63       -0.26
 DEC.        0.31            0.0           0.10          0.0            0.0          0.35       -0.14
 TOT.       27.58            0.0           5.57          2.68           0.0         17.75        1.67

  PERCENT OF WASTEWATER CONTROLLED=    100.00

  POTENTIAL DISPOSAL DAYS=   0

  PACK ON DECEMBER 31 = 0.0              CHANGE IN SNOW STORAGE=-0.08

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  16.85

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 36.50

  ESTIMATED LAKE EVAPORATION, INCHES = 38.96

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.38 OR 83.1 % OF ANNUAL
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                                ***** ANNUAL SUMMARY *****

                   WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1951
------------------------------------------------------------------------------------------------------------------
                     INFLOWS
        ------------------------------                                     OUTFLOWS
MONTH   PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  ---------------------------------------------
                                                           DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE    CHANGE IN VOL.
 JAN.       0.45           0.04              0.                0.0            0.07          0.0            0.42
 FEB.       1.11           0.36              0.                0.0            0.30          0.0            1.18
 MAR.       1.14           0.04              0.                0.0            0.86          0.0            0.32
 APR.       2.64           0.85              0.                0.0            2.17          0.0            1.32
 MAY        1.89           0.28              0.                0.0            3.24          0.0           -1.07
 JUNE       5.04           1.53              0.                0.0            3.57          0.0            3.01
 JULY       4.81           2.53              0.                0.0            4.13          0.0            3.22
 AUG.       1.71           0.04              0.                0.0            3.66          0.0           -1.91
 SEPT       2.82           0.69              0.                0.0            2.27          0.0            1.24
 OCT.       1.45           0.16              0.                0.0            1.40          0.0            0.21
 NOV.       0.35           0.01              0.                0.0            0.30          0.0            0.06
 DEC.       0.13           0.0               0.                0.0            0.09          0.0            0.04
 TOT.      23.53           6.54              0.                0.0           22.05          0.0            8.02
                        WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1951
------------------------------------------------------------------------------------------------------------------
                       INPUTS
          --------------------------                               OUTPUTS
MONTH     PRECIPITATION   IRRIGATION   ------------------------------------------------------------
                                       INTERCEPTION  SURFACE RUNOFF  PERCOLATION      AET      CHANGE IN SM
 JAN.         0.75           0.0           0.22           0.0            0.0          0.23         0.10
 FEB.         1.86           0.0           0.40           0.01           0.0          0.20         1.44
 MAR.         1.90           0.0           0.62           0.07           0.0          1.03         0.19
 APR.         4.40           0.0           0.63           0.80           0.0          2.16         0.81
 MAY          3.15           0.0           0.82           0.50           0.0          1.76         0.07
 JUNE         8.42           0.0           1.29           1.69           0.0          3.48         1.97
 JULY         8.03           0.0           0.78           2.19           1.27         6.26        -2.47
 AUG.         2.86           0.0           1.04           0.0            0.0          5.19        -3.37
 SEPT         4.71           0.0           0.83           0.12           0.0          2.64         1.12
 OCT.         2.42           0.0           0.70           0.29           0.0          0.76         0.67
 NOV.         0.58           0.0           0.25           0.00           0.0          0.55        -0.22
 DEC.         0.21           0.0           0.10           0.0            0.0          0.39        -0.28
 TOT.        39.29           0.0           7.69           5.67           1.27        24.62         0.03

 PERCENT OF WASTEWATER CONTROLLED=    100.00

 POTENTIAL DISPOSAL DAYS=    0

 PACK ON DECEMBER 31 = 0.0                      CHANGE IN SNOW STORAGE= 0.0

 INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

 PERCENT OF MAXIMUM POND VOLUME REQUIRED =  37.43

 ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 35.81

 ESTIMATED LAKE EVAPORATION, INCHES = 38.52

 MAY - OCTOBER LAKE EVAPORATION, INCHES = 31.87 OR 82.7 % OF ANNUAL
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                                 ***** ANNUAL SUMMARY *****

                 WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1952
------------------------------------------------------------------------------------------------------------
               INFLOWS
        ----------------------------                                  OUTFLOWS
MONTH   PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  ----------------------------------------
                                                          DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.       0.21           0.12              0.               0.0            0.13          0.0           0.20
 FEB.       0.52           0.01              0.               0.0            0.66          0.0          -0.13
 MAR.       1.61           0.53              0.               0.0            0.57          0.0           1.56
 APR.       1.99           0.33              0.               0.0            2.29          0.0           0.03
 MAY        1.64           0.11              0.               0.0            3.26          0.0          -1.50
 JUNE       0.98           0.22              0.               0.0            4.32          0.0          -3.12
 JULY       0.87           0.12              0.               0.0            4.47          0.0          -3.48
 AUG.       3.46           0.96              0.               0.0            3.65          0.0           0.76
 SEPT       0.41           0.07              0.               0.0            2.62          0.0          -2.14
 OCT.       0.0            0.0               0.               0.0            1.42          0.0          -1.42
 NOV.       0.80           0.13              0.               0.0            0.54          0.0           0.39
 DEC.       0.65           0.10              0.               0.0            0.06          0.0           0.69
 TOT.      13.14           2.70              0.               0.0           24.00          0.0          -8.17
                        WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1952
------------------------------------------------------------------------------------------------------------
                   INPUTS                                        OUTPUTS
          --------------------------   ----------------------------------------------------------
MONTH     PRECIPITATION   IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCOLATION      AET        CHANGE IN SM
 JAN.         0.35           0.0           0.12           0.0            0.0          0.31          -0.07
 FEB.         0.86           0.0           0.25           0.0            0.0          0.32           0.07
 MAR.         2.68           0.0           0.65           0.16           0.0          0.83           1.26
 APR.         3.32           0.0           0.88           0.12           0.0          1.93           0.39
 MAY          2.74           0.0           0.66           0.06           0.0          1.76           0.26
 JUNE         1.64           0.0           0.41           0.0            0.0          3.61          -2.38
 JULY         1.46           0.0           0.51           0.0            0.0          2.91          -1.96
 AUG.         5.77           0.0           0.91           0.06           0.0          3.77           1.03
 SEPT         0.69           0.0           0.30           0.0            0.0          1.80          -1.41
 OCT.         0.0            0.0           0.0            0.0            0.0          0.08          -0.08
 NOV.         1.34           0.0           0.10           0.0            0.0          0.12           0.74
 DEC.         1.08           0.0           0.16           0.0            0.0          0.25           0.13
 TOT.        21.93           0.0           4.95           0.40           0.0         17.67          -2.02
PERCENT OF WASTEWATER CONTROLLED=    100.00

POTENTIAL DISPOSAL DAYS=   0

PACK ON DECEMBER 31 = 0.92              CHANGE IN SNOW STORAGE= 0.92

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED =  38.65

ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 38.00

ESTIMATED LAKE EVAPORATION, INCHES = 41.98

MAY - OCTOBER LAKE EVAPORATION, INCHES = 34.58 OR 82.4 % OF ANNUAL
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                              ***** ANNUAL SUMMARY *****

          WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1953

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                    INFLOWS                                              OUTFLOWS
        ------------------------------                 ------------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE     CHANGE IN VOL.
 JAN.       0.04            0.31               0.              0.0            0.10         0.0             0.25
 FEB.       0.26            0.00               0.              0.0            0.59         0.0            -0.33
 MAR.       0.97            0.10               0.              0.0            1.33         0.0            -0.26
 APR.       1.16            0.03               0.              0.0            2.20         0.0            -1.02
 MAY        1.72            0.63               0.              0.0            3.16         0.0            -0.82
 JUNE       2.19            0.29               0.              0.0            4.15         0.0            -1.67
 JULY       1.55            0.30               0.              0.0            3.55         0.0            -1.71
 AUG.       1.20            0.26               0.              0.0            1.46         0.0             0.00
 SEPT       1.13            0.45               0.              0.0            1.58         0.0            -0.00
 OCT.       0.72            0.10               0.              0.0            0.72         0.0             0.11
 NOV.       1.91            0.76               0.              0.0            0.50         0.0             2.18
 DEC.       1.05            0.43               0.              0.0            0.20         0.0             1.29
 TOT.      13.90            3.67               0.              0.0           19.55         0.0            -1.98

                    WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1953
-----------------------------------------------------------------------------------------------------------------
                        INPUTS                                          OUTPUTS
           ----------------------------   -----------------------------------------------------------
MONTH        PRECIPITATION    IRRIGATION   INTERCEPTION  SURFACE RUNOFF   PERCOLATION        AET        CHANGE IN SM
 JAN.            0.06            0.0           0.26          0.0            0.0            0.25           0.48
 FEB.            0.44            0.0           0.42          0.0            0.0            0.21          -0.19
 MAR.            1.62            0.0           0.31          0.0            0.0            1.02           0.30
 APR.            1.93            0.0           0.79          0.0            0.0            0.52           0.62
 MAY             2.87            0.0           0.50          0.39           0.0            1.25           0.73
 JUNE            3.66            0.0           0.82          0.24           0.0            3.19          -0.59
 JULY            2.58            0.0           0.71          0.0            0.0            3.95          -2.08
 AUG.            2.00            0.0           0.51          0.0            0.0            1.70          -0.21
 SEPT            1.89            0.0           0.26          0.00           0.0            1.56           0.07
 OCT.            1.21            0.0           0.37          0.0            0.0            0.35           0.48
 NOV.            3.19            0.0           0.40          0.38           0.0            0.56           1.86
 DEC.            1.76            0.0           0.16          0.46           0.0            0.41           0.72
 TOT.           23.21            0.0           5.51          1.47           0.0           14.97           2.19
  PERCENT OF WASTEWATER CONTROLLED=    100.00

  POTENTIAL DISPOSAL DAYS=   0

  PACK ON DECEMBER 31 = 0.0              CHANGE IN SNOW STORAGE=-0.92

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  14.61

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 39.24

  ESTIMATED LAKE EVAPORATION, INCHES = 43.29

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 34.60 OR 79.9 % OF ANNUAL
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                              ***** ANNUAL SUMMARY *****

                WATER ACCOUNT FOR STORAGE FACI'ITY (IN INCHES OVER DISPOSAL AREA) - 1954
---------------------------------------------------------------------------------------------------------------
                  INFLOWS
        ----------------------------                                          OUTFLOWS
MONTH   PRECIPITATION  FEEDLOT RUNOFF                          -------------------------------------
                                        NO. DISPOSAL DAYS    DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE    CHANGE IN VOL.
 JAN.       0.03          0.0                0.                  0.0            0.17          0.0          -0.14
 FEB.       0.47          0.03               0.                  0.0            0.83          0.0          -0.33
 MAR.       0.10          0.0                0.                  0.0            1.01          0.0          -0.91
 APR.       1.12          0.14               0.                  0.0            2.40          0.0          -1.14
 MAY        3.85          1.55               0.                  0.0            2.99          0.0           2.40
 JUNE       1.29          0.22               0.                  0.0            3.95          0.0          -2.44
 JULY       1.16          0.01               0.                  0.0            2.10          0.0          -0.93
 AUG.       5.37          1.73               0.                  0.0            3.62          0.0           3.48
 SEPT       0.94          0.15               0.                  0.0            2.67          0.0          -1.58
 OCT.       1.35          0.19               0.                  0.0            1.46          0.0           0.07
 NOV.       0.0           0.0                0.                  0.0            0.70          0.0          -0.70
 DEC.       0.23          0.0                0.                  0.0            0.16          0.0           0.06
 TOT.      15.90          4.01               0.                  0.0           22.08          0.0          -2.16
                      WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1954
---------------------------------------------------------------------------------------------------------------
                     INPUTS
            ---------------------------                       OUTPUTS
MONTH                                   -----------------------------------------------------------
            PRECIPITATION   IRRIGATION  INTERCEPTION  SURFACE RUNOFF  PERCOLATION      AET       CHANGE IN SM
 JAN.           0.05           0.0          0.05           0.0            0.0          0.31         -0.31
 FEB.           0.79           0.0          0.20           0.0            0.0          0.44          0.15
 MAR.           0.17           0.0          0.17           0.0            0.0          0.35         -0.35
 APR.           1.87           0.0          0.42           0.01           0.0          0.50          0.95
 MAY            6.42           0.0          0.91           1.89           0.0          1.61          2.02
 JUNE           2.15           0.0          0.64           0.13           0.0          3.89         -2.51
 JULY           1.94           0.0          0.62           0.0            0.0          3.59         -2.27
 AUG.           8.96           0.0          1.53           0.56           0.0          4.98          1.90
 SEPT           1.57           0.0          0.23           0.0            0.0          2.82         -1.48
 OCT.           2.25           0.0          0.67           0.0            0.0          0.70          0.88
 NOV.           0.0            0.0          0.0            0.0            0.0          0.75         -0.75
 DEC.           0.38           0.0          0.13           0.0            0.0          0.26         -0.02
 TOT.          26.55           0.0          5.57           2.58           0.0         20.19         -1.80
PERCENT OF WASTEWATER CONTROLLED=    100.00

POTENTIAL DISPOSAL DAYS=    0

PACK ON DECEMBER 31 = 0.01              CHANGE IN SNOW STORAGE= 0.01

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED =   9.66

ESTIMATED POTENTIAL EVAPOTRANSPIRATICN, INCHES = 39.68

ESTIMATED LAKE EVAPORATION, INCHES = 43.65

MAY - OCTOBER LAKE EVAPORATION, INCHES = 34.29 OR 78.5 % OF ANNUAL
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                         ***** ANNUAL SUMMARY *****

       WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1955
------------------------------------------------------------------------------------------------
              INFLOWS                                         OUTFLOWS
       ----------------------------                ---------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE  CHANGE IN VOL.
 JAN.      0.56           0.0              0.              0.0            0.04          0.0         0.52
 FEB.      0.72           0.0              0.              0.0            0.0           0.0         0.72
 MAR.      0.15           0.81             0.              0.0            0.94          0.0         0.02
 APR.      0.47           0.0              0.              0.0            2.56          0.0        -2.09
 MAY       1.27           0.13             0.              0.0            1.79          0.0        -0.39
 JUNE      3.57           1.56             0.              0.0            3.45          0.0         1.69
 JULY      0.78           0.01             0.              0.0            2.67          0.0        -1.88
 AUG.      0.13           0.0              0.              0.0            0.13          0.0         0.00
 SEPT      3.58           1.61             0.              0.0            0.85          0.0         4.34
 OCT.      0.71           0.0              0.              0.0            1.46          0.0        -0.75
 NOV.      0.09           0.0              0.              0.0            0.41          0.0        -0.32
 DEC.      0.43           0.19             0.              0.0            0.05          0.0         0.56
 TOT.     12.45           4.32             0.              0.0           14.35          0.0         2.42
                    WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1955
------------------------------------------------------------------------------------------------
                 INPUTS                                   OUTPUTS
          --------------------------      -------------------------------------------------
MONTH     PRECIPITATION   IRRIGATION     INTERCEPTION  SURFACE RUNOFF  PERCOLATION    AET      CHANGE IN SM
 JAN.         0.94           0.0             0.35           0.0            0.0        0.35        0.16
 FEB.         1.21           0.0             0.20           0.0            0.0        0.29        0.42
 MAR.         0.25           0.0             0.27           0.0            0.0        0.32        0.04
 APR.         0.78           0.0             0.37           0.0            0.0        0.26        0.15
 MAY          2.12           0.0             0.63           0.00           0.0        1.41        0.08
 JUNE         5.96           0.0             0.79           1.63           0.0        3.08        0.46
 JULY         1.30           0.0             0.68           0.0            0.0        2.89       -2.27
 AUG.         0.22           0.0             0.16           0.0            0.0        0.35       -0.29
 SEPT         5.97           0.0             0.78           0.43           0.0        0.83        3.93
 OCT.         1.18           0.0             0.41           0.03           0.0        1.01       -0.28
 NOV.         0.15           0.0             0.15           0.0            0.0        0.54       -0.54
 DEC.         0.71           0.0             0.15           0.0            0.0        0.23        0.33
 TOT.        20.79           0.0             4.94           2.10           0.0       11.55        2.21
  PERCENT OF WASTEWATER CONTROLLED=     100.00

  POTENTIAL DISPOSAL DAYS=    0

  PACK ON DECEMBER 31 = 0.0                 CHANGE IN SNOW STORAGE=-0.01

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  11.06

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 38.37

  ESTIMATED LAKE EVAPORATION, INCHES = 41.84

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 34.75 OR 83.1 % OF ANNUAL
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***** ANNUAL SUMMARY *****

WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1956
------------------------------------------------------------------------------------------------------------
              INFLOWS                                                  OUTFLOWS
       ---------------------------                        ----------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.      0.40           0.0               0.               0.0            0.05          0.0          0.35
 FEB.      0.32           0.0               0.               0.0            0.0           0.0          0.32
 MAR.      0.02           0.42              0.               0.0            1.15          0.0         -0.71
 APR.      0.72           0.0               0.               0.0            2.25          0.0         -1.53
 MAY       1.31           0.24              0.               0.0            2.77          0.0         -1.23
 JUNE      3.45           1.14              0.               0.0            3.30          0.0          1.29
 JULY      1.29           0.37              0.               0.0            3.97          0.0         -2.31
 AUG.      0.81           0.0               0.               0.0            0.61          0.0          0.20
 SEPT      0.01           0.0               0.               0.0            0.21          0.0         -0.20
 OCT.      0.87           0.06              0.               0.0            0.55          0.0          0.39
 NOV.      0.30           0.00              0.               0.0            0.54          0.0         -0.24
 DEC.      0.02           0.0               0.               0.0            0.15          0.0         -0.12
 TOT.      9.52           2.23              0.               0.0           15.54          0.0         -3.79

                     WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1956
------------------------------------------------------------------------------------------------------------
              INPUTS                                        OUTPUTS
       ---------------------------   -----------------------------------------------------------
MONTH  PRECIPITATION  IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCOLATION     AET      CHANGE IN SM
 JAN.      0.66          0.0           0.0           0.0            0.0          0.25       -0.20
 FEB.      0.54          0.0           0.25          0.0            0.0          0.39        0.50
 MAR.      0.04          0.0           0.04          0.0            0.0          0.27       -0.27
 APR.      1.20          0.0           0.44          0.0            0.0          0.52        0.24
 MAY       2.18          0.0           0.62          0.01           0.0          1.78       -0.23
 JUNE      5.76          0.0           1.04          0.69           0.0          3.61        0.41
 JULY      2.15          0.0           0.66          0.30           0.0          4.45       -3.26
 AUG.      1.36          0.0           0.58          0.0            0.0          0.90       -0.12
 SEPT      0.01          0.0           0.01          0.0            0.0          0.52       -0.52
 OCT.      1.46          0.0           0.35          0.0            0.0          0.25        0.86
 NOV.      0.50          0.0           0.22          0.0            0.0          0.59       -0.31
 DEC.      0.04          0.0           0.04          0.0            0.0          0.32       -0.32
 TOT.     15.90          0.0           4.25          0.99           0.0         13.86       -3.20

PERCENT OF WASTEWATER CONTROLLED=    100.00

POTENTIAL DISPOSAL DAYS=    0

PACK ON DECEMBER 31 = 0.0                      CHANGE IN SNOW STORAGE= 0.0

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED =  11.63

ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 39.01

ESTIMATED LAKE EVAPORATION, INCHES = 42.67

MAY - OCTOBER LAKE EVAPORATION, INCHES = 35.35 OR 82.9 % OF ANNUAL
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                              ***** ANNUAL SUMMARY *****
            WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1957
-----------------------------------------------------------------------------------------------------------
                  INFLOWS                                                 OUTFLOWS
        ------------------------------                     ------------------------------------------
MONTH   PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.       0.17           0.0               0.                0.0           0.01          0.0           0.15
 FEB.       0.25           0.07              0.                0.0           0.34          0.0          -0.02
 MAR.       1.09           0.24              0.                0.0           0.69          0.0           0.64
 APR.       2.52           0.74              0.                0.0           1.81          0.0           1.44
 MAY        2.61           0.47              0.                0.0           3.08          0.0           0.00
 JUNE       4.64           1.51              0.                0.0           3.72          0.0           2.43
 JULY       0.69           0.16              0.                0.0           4.48          0.0          -3.62
 AUG.       2.99           1.33              0.                0.0           2.89          0.0           1.43
 SEPT       1.28           0.21              0.                0.0           2.33          0.0          -0.84
 OCT.       0.91           0.04              0.                0.0           1.28          0.0          -0.33
 NOV.       0.87           0.17              0.                0.0           0.44          0.0           0.60
 DEC.       0.41           0.0               0.                0.0           0.33          0.0           0.08
 TOT.      18.43           4.93              0.                0.0          21.40          0.0           1.96
                           WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1957
-----------------------------------------------------------------------------------------------------------
                 INPUTS                                           OUTPUTS
        ------------------------------   ------------------------------------------------------
MONTH   PRECIPITATION   IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCOLATION     AET      CHANGE IN SM
 JAN.       0.28          0.0           0.11          0.0            0.0          0.10       -0.08
 FEB.       0.42          0.0           0.27          0.0            0.0          0.27        0.04
 MAR.       1.82          0.0           0.53          0.0            0.0          0.27        1.02
 APR.       4.20          0.0           0.82          0.06           0.0          1.77        1.55
 MAY        4.36          0.0           1.10          0.37           0.0          1.56        1.34
 JUNE       7.74          0.0           1.39          1.85           0.0          3.59        0.92
 JULY       1.16          0.0           0.34          0.10           0.0          4.75       -4.03
 AUG.       4.99          0.0           0.60          0.30           0.0          2.93        1.16
 SEPT       2.14          0.0           0.55          0.05           0.0          2.52       -0.98
 OCT.       1.52          0.0           0.58          0.0            0.0          0.66        0.28
 NOV.       1.46          0.0           0.48          0.0            0.0          0.48        0.49
 DEC.       0.68          0.0           0.15          0.0            0.0          0.34       -0.26
 TOT.      30.77          0.0           6.92          2.73           0.0         19.23        1.45
PERCENT OF WASTEWATER CONTROLLED=    100.00

POTENTIAL DISPOSAL DAYS=   0

PACK ON DECEMBER 31 = 0.45                   CHANGE IN SNOW STORAGE= 0.45

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED =  12.30

ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 36.95

ESTIMATED LAKE EVAPORATION, INCHES = 40.61

MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.06 OR 81.4 % OF ANNUAL
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                                   ***** ANNUAL SUMMARY *****
        9/ 5/58  CRITICAL EVENT EXCEEDED          7.03  INCH STORM

                 WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1958
----------------------------------------------------------------------------------------------------------------
                  INFLOWS                                                 OUTFLOWS
         ------------------------------                   ---------------------------------------
MONTH    PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE    CHANGE IN VCL.
 JAN.        0.70           0.08               0.               0.0            0.06          0.0           0.72
 FEB.        0.50           0.29               0.               0.0            0.16          0.0           0.63
 MAR.        1.84           1.15               0.               0.0            0.43          0.0           2.56
 APR.        1.09           0.04               0.               0.0            2.22          0.0          -1.09
 MAY         2.50           1.00               0.               0.0            3.27          0.0           0.24
 JUNE        2.17           0.34               0.               0.0            3.76          0.0          -1.24
 JULY        5.81           2.50               0.               0.0            4.10          0.0           4.21
 AUG.        0.97           0.06               0.               0.0            3.66          0.0          -2.63
 SEPT        7.00           4.05               0.               0.0            2.49          0.0           8.56
 OCT.        0.10           0.0                0.               0.0            1.50          0.0          -1.40
 NOV.        0.55           0.05               0.               0.0            0.60          0.0           0.00
 DEC.        0.05           0.02               0.               0.0            0.04          0.0           0.03
 TOT.       23.29           9.58               0.               0.0           22.27          0.0          10.59
                         WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1958
----------------------------------------------------------------------------------------------------------------
                     INPUTS                                    OUTPUTS
              --------------------------  ------------------------------------------------------
MONTH     PRECIPITATION   IRRIGATION  INTERCEPTION  SURFACE RUNOFF  PERCOLATION     AET      CHANGE IN SM
 JAN.         1.17           0.0          0.37           0.0            0.0         0.26         0.69
 FEB.         0.84           0.0          0.24           0.03           0.0         0.37         0.25
 MAR.         3.07           0.0          0.57           0.24           0.0         0.71         1.81
 APR.         1.82           0.0          0.76           0.01           0.0         1.64        -0.59
 MAY          4.18           0.0          0.56           1.27           0.0         1.78         0.57
 JUNE         3.63           0.0          0.81           0.16           0.0         3.63        -0.98
 JULY         9.70           0.0          1.48           2.85           0.0         5.90        -0.52
 AUG.         1.62           0.0          0.65           0.0            0.0         3.47        -2.50
 SEPT        11.68           0.0          0.99           3.01           0.0         3.00         4.68
 OCT.         0.17           0.0          0.10           0.0            0.0         1.14        -1.07
 NOV.         0.92           0.0          0.13           0.00           0.0         0.71        -0.09
 DEC.         0.08           0.0          0.21           0.0            0.0         0.21        -0.17
 TOT.        38.88           0.0          6.88           7.57           0.0        22.82         2.06
 PERCENT OF WASTEWATER CONTROLLED=    100.00

 POTENTIAL DISPOSAL DAYS=    0

 PACK ON DECEMBER 31 = 0.0                CHANGE IN SNOW STORAGE=-0.45

 INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

 PERCENT OF MAXIMUM POND VOLUME REQUIRED =  34.43

 ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 35.73

 ESTIMATED LAKE EVAPORATION, INCHES = 39.16

 MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.98 OR 84.2 % OF ANNUAL
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                              ***** ANNUAL SUMMARY *****

          WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1959
--------------------------------------------------------------------------------------------------------------------
              INFLOWS                                                  OUTFLOWS
       ------------------------------                     ---------------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.      0.22          0.01                0.               0.0           0.05          0.0           0.18
 FEB.      0.49          0.37                0.               0.0           0.12          0.0           0.74
 MAR.      1.36          0.43                0.               0.0           1.37          0.0           0.43
 APR.      0.63          0.0                 0.               0.0           2.35          0.0          -1.72
 MAY       3.77          1.22                0.               0.0           3.30          0.0           1.69
 JUNE      1.11          0.14                0.               0.0           3.97          0.0          -2.72
 JULY      0.98          0.04                0.               0.0           4.23          0.0          -3.20
 AUG.      0.84          0.23                0.               0.0           3.97          0.0          -2.90
 SEPT      2.95          1.06                0.               0.0           2.46          0.0           1.56
 OCT.      2.90          0.75                0.               0.0           1.34          0.0           2.31
 NOV.      0.0           0.0                 0.               0.0           0.35          0.0          -0.35
 DEC.      0.38          0.0                 0.               0.0           0.26          0.0           0.13
 TOT.     15.63          4.26                0.               0.0          23.76          0.0          -3.87
                     WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1959
--------------------------------------------------------------------------------------------------------------------
                 INPUTS                                        OUTPUTS
       ---------------------------      ----------------------------------------------------------
MONTH  PRECIPITATION   IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCOLATION      AET      CHANGE IN SM
 JAN.      0.36           0.0           0.11           0.0            0.0          0.12        -0.07
 FEB.      0.81           0.0           0.27           0.0            0.0          0.22         0.52
 MAR.      2.27           0.0           0.66           0.19           0.0          0.41         1.01
 APR.      1.05           0.0           0.47           0.0            0.0          1.14        -0.55
 MAY       6.30           0.0           1.03           1.29           0.0          1.78         2.20
 JUNE      1.86           0.0           0.53           0.00           0.0          3.85        -2.52
 JULY      1.64           0.0           0.52           0.0            0.0          4.42        -3.30
 AUG.      1.40           0.0           0.27           0.0            0.0          1.06         0.07
 SEPT      4.93           0.0           0.86           0.56           0.0          1.88         1.63
 OCT.      4.84           0.0           0.66           1.21           0.0          0.80         2.17
 NOV.      0.0            0.0           0.0            0.0            0.0          0.79        -0.79
 DEC.      0.64           0.0           0.13           0.0            0.0          0.49        -0.22
 TOT.     26.10           0.0           5.51           3.26           0.0         16.96         0.14
  PERCENT OF WASTEWATER CONTROLLED=    100.00

  POTENTIAL DISPOSAL DAYS=   0

  PACK ON DECEMBER 31 = 0.23              CHANGE IN SNOW STORAGE= 0.23

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  35.11

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 37.80

  ESTIMATED LAKE EVAPORATION, INCHES = 41.57

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.75 OR 81.2 % OF ANNUAL
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                          ***** ANNUAL SUMMARY *****

          WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1960
------------------------------------------------------------------------------------------------------
                 INFLCWS
       -----------------------------                                      OUTFLCWS
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  ------------------------------------------
                                                          DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VCL.
 JAN.      1.16           0.0               0.                0.0           0.0           0.0           1.16
 FEB.      0.83           0.02              0.                0.0           0.06          0.0           1.58
 MAR.      1.20           1.34              0.                0.0           0.21          0.0           2.33
 APR.      1.61           0.12              0.                0.0           2.45          0.0          -0.72
 MAY       1.62           0.17              0.                0.0           3.24          0.0          -1.45
 JUNE      3.75           0.98              0.                0.0           3.75          0.0           0.97
 JULY      1.33           0.05              0.                0.0           4.23          0.0          -2.85
 AUG.      2.77           0.54              0.                0.0           3.71          0.0          -0.41
 SEPT      1.87           0.64              0.                0.0           2.55          0.0          -0.03
 OCT.      0.82           0.12              0.                0.0           1.49          0.0          -0.56
 NOV.      0.23           0.0               0.                0.0           0.56          0.0          -0.33
 DEC.      0.30           0.0               0.                0.0           0.04          0.0           0.26
 TOT.     17.47           4.77              0.                0.0          22.29          0.0          -0.05
                        WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1960
------------------------------------------------------------------------------------------------------
                     INPUTS
          ----------------------------                       OUTPUTS
MONTH                               ----------------------------------------------------------
          PRECIPITATION  IRRIGATION  INTERCEPTION  SURFACE RUNOFF  PERCOLATION     AET       CHANGE IN SM
 JAN.         1.94          0.0         0.26           0.0            0.0          0.19         0.35
 FEB.         1.38          0.0         0.19           0.01           0.0          0.24         1.34
 MAR.         2.00          0.0         0.21           0.71           0.0          0.52         1.54
 APR.         2.68          0.0         0.77           0.09           0.03         1.33         0.45
 MAY          2.70          0.0         0.73           0.38           0.37         1.75        -0.53
 JUNE         6.26          0.0         1.11           1.46           0.0          3.65         0.04
 JULY         2.22          0.0         0.77           0.0            0.0          6.45        -5.00
 AUG.         4.62          0.0         0.77           0.0            0.0          3.95        -0.10
 SEPT         3.12          0.0         0.47           0.00           0.0          2.11         0.53
 OCT.         1.37          0.0         0.27           0.03           0.0          0.86         0.21
 NOV.         0.38          0.0         0.10           0.0            0.0          0.86        -0.58
 DEC.         0.50          0.0         0.21           0.0            0.0          0.25         0.01
 TOT.        29.17          0.0         5.85           2.68           0.40        22.17        -1.74
 PERCENT OF WASTEWATER CONTROLLED=    100.00

 POTENTIAL DISPOSAL DAYS=    0

 PACK ON DECEMBER 31 = 0.04                 CHANGE IN SNOW STORAGE=-0.20

 INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

 PERCENT OF MAXIMUM POND VOLUME REQUIRED =  34.16

 ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 35.45

 ESTIMATED LAKE EVAPORATION, INCHES = 38.96

 MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.18 OR 85.2 % OF ANNUAL
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                                 ***** ANNUAL SUMMARY *****
          9/12/61  CRITICAL EVENT EXCEEDED           6.11  INCH STORM

                  WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1961

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                  INFLCWS                                                   OUTFLOWS
          ------------------------------                   ----------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE    CHANGE IN VCL.
 JAN.       0.05          0.07                0.                0.0           0.06          0.0            0.07
 FEB.       0.25          0.07                0.                0.0           0.41          0.0           -0.08
 MAR.       1.96          0.36                0.                0.0           1.32          0.0            1.00
 APR.       1.11          0.10                0.                0.0           2.22          0.0           -1.01
 MAY        4.56          1.54                0.                0.0           3.09          0.0            3.01
 JUNE       2.32          0.83                0.                0.0           3.83          0.0           -0.68
 JULY       1.44          0.47                0.                0.0           4.37          0.0           -2.46
 AUG.       1.35          0.18                0.                0.0           3.64          0.0           -2.12
 SEPT       6.52          4.05                0.                0.0           2.32          0.0            8.25
 OCT.       1.29          0.35                0.                0.0           1.47          0.0            0.17
 NOV.       1.35          0.42                0.                0.0           0.39          0.0            1.37
 DEC.       0.50          0.0                 0.                0.0           0.09          0.0            0.41
 TOT.      22.69          8.45                0.                0.0          23.20          0.0            7.94

                            WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1961
-------------------------------------------------------------------------------------------------------------
                       INPUTS                                      OUTPUTS
              ---------------------------   ------------------------------------------------------
MONTH       PRECIPITATION     IRRIGATION    INTERCEPTION  SURFACE RUNOFF    PERCOLATION         AET      CHANGE IN SM
 JAN.           0.08             0.0            0.11           0.0              0.0             0.27         -0.27
 FEB.           0.42             0.0            0.19           0.0              0.0             0.25         -0.01
 MAR.           3.27             0.0            0.63           0.42             0.0             1.12          1.10
 APR.           1.86             0.0            0.49           0.01             0.0             1.80         -0.44
 MAY            7.61             0.0            1.36           1.46             0.0             1.62          3.16
 JUNE           3.88             0.0            0.78           0.86             0.0             3.72         -1.48
 JULY           2.40             0.0            0.50           0.01             0.0             4.95         -3.06
 AUG.           2.25             0.0            0.63           0.0              0.0             2.47         -0.85
 SEPT          10.88             0.0            0.80           2.99             0.0             1.95          5.14
 OCT.           2.16             0.0            0.35           0.61             0.0             1.02          0.17
 NOV.           2.25             0.0            0.37           0.06             0.0             0.45          1.37
 DEC.           0.83             0.0            0.0            0.0              0.0             0.30         -0.19
 TOT.          37.89             0.0            6.21           6.42             0.0            19.92          4.65
  PERCENT OF WASTEWATER CONTROLLED=    100.00

  POTENTIAL DISPOSAL DAYS=   0

  PACK ON DECEMBER 31 = 0.72               CHANGE IN SNOW STORAGE= 0.68

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  39.74

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 36.78

  ESTIMATED LAKE EVAPORATION, INCHES = 40.59

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.75 OR 80.7 % CF ANNUAL
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                         ***** ANNUAL SUMMARY *****

         WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1962
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                 INFLCWS                                                  OUTFLOWS
       ------------------------------                    ------------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.      0.59           0.0              0.               0.0            0.0           0.0           0.59
 FEB.      0.58           0.73             0.               0.0            0.38          0.0           0.93
 MAR.      1.45           0.37             0.               0.0            0.73          0.0           1.08
 APR.      0.44           0.0              0.               0.0            2.36          0.0          -1.92
 MAY       2.78           1.03             0.               0.0            3.60          0.0           0.21
 JUNE      3.96           1.37             0.               0.0            3.83          0.0           1.50
 JULY      2.88           0.38             0.               0.0            4.23          0.0          -0.97
 AUG.      1.80           0.24             0.               0.0            3.73          0.0          -1.69
 SEPT      2.22           0.19             0.               0.0            2.38          0.0           0.03
 OCT.      1.43           0.29             0.               0.0            1.51          0.0           0.20
 NOV.      0.42           0.01             0.               0.0            0.63          0.0          -0.20
 DEC.      0.40           0.0              0.               0.0            0.15          0.0           0.25
 TOT.     18.95           4.61             0.               0.0           23.55          0.0           0.01
                      WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1962
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                    INPUTS                                        OUTPUTS
         ----------------------------  ---------------------------------------------------------
MONTH     PRECIPITATION    IRRIGATION  INTERCEPTION  SURFACE RUNOFF  PERCOLATICN      AET       CHANGE IN SM
 JAN.         0.99            0.0          0.25          0.28           0.08          0.26          0.84
 FEB.         0.97            0.0          0.18          0.0            0.0           0.69         -0.25
 MAR.         2.42            0.0          0.69          0.34           0.99          0.88         -0.12
 APR.         0.74            0.0          0.44          0.0            0.0           0.91         -0.61
 MAY          4.64            0.0          0.89          1.08           0.0           1.94          0.72
 JUNE         6.61            0.0          1.20          1.19           0.81          3.68         -0.27
 JULY         4.81            0.0          1.19          0.01           0.0           6.37         -2.76
 AUG.         3.01            0.0          0.51          0.0            0.0           4.89         -2.39
 SEPT         3.70            0.0          1.17          0.0            0.0           2.71         -0.18
 OCT.         2.38            0.0          0.37          0.06           0.0           0.82          1.13
 NOV.         0.70            0.0          0.26          0.0            0.0           0.74         -0.29
 DEC.         0.66            0.0          0.24          0.0            0.0           0.32         -0.13
 TOT.        31.63            0.0          7.39          2.96           1.88         24.21         -4.34
  PERCENT OF WASTEWATER CONTROLLED=    100.00

  POTENTIAL DISPOSAL DAYS=   0

  PACK ON DECEMBER 31 = 0.24              CHANGE IN SNOW STORAGE=-0.48

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  46.76

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 37.21

  ESTIMATED LAKE EVAPORATION, INCHES = 40.74

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.38 OR 81.9 % OF ANNUAL
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                          ***** ANNUAL SUMMARY *****

          WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1963

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               INFLCWS                                               OUTFLGWS
        -------------------------------                -------------------------------------
MONTH   PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE    CHANGE IN VOL.
 JAN.        0.67          0.18              0.              0.0            0.02          0.0            0.84
 FEB.        0.0           0.05              0.              0.0            0.23          0.0           -0.18
 MAR.        1.22          0.41              0.              0.0            1.30          0.0            0.34
 APR.        1.36          0.13              0.              0.0            2.41          0.0           -0.91
 MAY         0.61          0.0               0.              0.0            3.28          0.0           -2.67
 JUNE        1.84          0.18              0.              0.0            4.03          0.0           -2.01
 JULY        2.97          1.11              0.              0.0            4.37          0.0           -0.28
 AUG.        2.02          0.60              0.              0.0            3.65          0.0           -1.03
 SEPT        3.62          1.24              0.              0.0            2.48          0.0            2.39
 OCT.        1.15          0.28              0.              0.0            1.66          0.0           -0.23
 NOV.        0.04          0.0               0.              0.0            0.63          0.0           -0.59
 DEC.        0.20          0.00              0.              0.0            0.11          0.0            0.10
 TOT.       15.71          4.21              0.              0.0           24.17          0.0           -4.25
                    WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1963
-----------------------------------------------------------------------------------------------
                   INPUTS                                  OUTPUTS
           ------------------------    -------------------------------------------------
MONTH     PRECIPITATION    IRRIGATION   INTERCEPTION  SURFACE RUNOFF   PERCOLATION       AET      CHANGE IN SM
 JAN.          1.12            0.0          0.15           0.0             0.0          0.16          0.45
 FEB.          0.0             0.0          0.14           0.01            0.0          0.85         -0.40
 MAR.          2.04            0.0          0.64           0.14            0.0          1.10          0.16
 APR.          2.27            0.0          0.60           0.19            0.0          0.58          0.90
 MAY           1.02            0.0          0.58           0.0             0.0          1.53         -1.09
 JUNE          3.07            0.0          0.84           0.0             0.0          3.16         -0.93
 JULY          4.96            0.0          0.82           0.17            0.0          4.71         -0.73
 AUG.          3.37            0.0          0.52           0.01            0.0          3.13         -0.29
 SEPT          6.05            0.0          0.80           0.54            0.0          2.55          2.15
 OCT.          1.92            0.0          0.20           0.20            0.0          1.03          0.49
 NOV.          0.07            0.0          0.07           0.0             0.0          0.91         -0.91
 DEC.          0.34            0.0          0.10           0.0             0.0          0.20         -0.06
 TOT.         26.23            0.0          5.45           1.26            0.0         19.90         -0.25
  PERCENT OF WASTEWATER CONTROLLED=    100.00

  POTENTIAL DISPOSAL DAYS=   0

  PACK ON DECEMBER 31 = 0.10              CHANGE IN SNOW STORAGE=-0.14

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  44.02

  ESTIMATED POTENTIAL EVAPOTRANSPIRATICN, INCHES = 38.17

  ESTIMATED LAKE EVAPORATION, INCHES = 42.08

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.94 OR 80.6 % CF ANNUAL
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                         ***** ANNUAL SUMMARY *****

         WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1964
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              INFLOWS                                            OUTFLOWS
       ------------------------------              -----------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE  CHANGE IN VOL.
 JAN.      0.01           0.00              0.               0.0            0.18         0.0        -0.16
 FEB.      0.34           0.0               0.               0.0            0.16         0.0         0.18
 MAR.      0.63           0.11              0.               0.0            0.68         0.0         0.06
 APR.      1.96           0.25              0.               0.0            2.35         0.0        -0.14
 MAY       0.80           0.0               0.               0.0            3.39         0.0        -2.59
 JUNE      2.77           0.72              0.               0.0            3.77         0.0        -0.28
 JULY      1.20           0.30              0.               0.0            4.56         0.0        -3.06
 AUG.      2.13           0.25              0.               0.0            3.47         0.0        -1.09
 SEPT      1.67           0.22              0.               0.0            2.37         0.0        -0.48
 OCT.      0.19           0.0               0.               0.0            1.43         0.0        -1.24
 NOV.      0.52           0.00              0.               0.0            0.50         0.0         0.02
 DEC.      0.25           0.07              0.               0.0            0.03         0.0         0.28
 TOT.     12.46           1.93              0.               0.0           22.89         0.0        -8.51
                    WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1964
-----------------------------------------------------------------------------------------------------
              INPUTS                                          OUTPUTS
       --------------------------    ----------------------------------------------------------
MONTH  PRECIPITATION  IRRIGATION  INTERCEPTION  SURFACE RUNOFF  PERCOLATION   AET   CHANGE IN SM
 JAN.      0.02          0.0          0.12           0.0            0.0       0.27      -0.27
 FEB.      0.57          0.0          0.22           0.0            0.0       0.19       0.16
 MAR.      1.05          0.0          0.32           0.0            0.0       0.32       0.41
 APR.      3.27          0.0          0.70           0.39           0.0       0.92       1.26
 MAY       1.33          0.0          0.58           0.00           0.0       1.68      -0.94
 JUNE      4.63          0.0          0.91           0.60           0.0       3.32      -0.19
 JULY      2.00          0.0          0.30           0.0            0.0       3.84      -2.14
 AUG.      3.55          0.0          0.95           0.0            0.0       2.11       0.49
 SEPT      2.79          0.0          0.75           0.0            0.0       2.38      -0.34
 OCT.      0.31          0.0          0.15           0.0            0.0       0.55      -0.39
 NOV.      0.86          0.0          0.29           0.0            0.0       0.53       0.04
 DEC.      0.42          0.0          0.10           0.0            0.0       0.24       0.08
 TOT.     20.80          0.0          5.40           0.99           0.0      16.36      -1.85
PERCENT OF WASTEWATER CONTROLLED=    100.00

POTENTIAL DISPOSAL DAYS=   0

PACK ON DECEMBER 31 = 0.0                 CHANGE IN SNOW STORAGE=-0.10

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED =  29.94

ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 37.73

ESTIMATED LAKE EVAPORATION, INCHES = 40.17

MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.35 OR 83.0 % OF ANNUAL
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                           ***** ANNUAL SUMMARY *****

         WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1965
------------------------------------------------------------------------------------------------------
                  INFLOWS                                                 OUTFLOWS
         ----------------------------                      ------------------------------------
MONTH    PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE    CHANGE IN VOL.
 JAN.        0.49           0.02               0.               0.0           0.03          0.0           0.48
 FEB.        1.88           1.52               0.               0.0           0.03          0.0           3.37
 MAR.        0.99           0.18               0.               0.0           0.05          0.0           1.12
 APR.        0.69           0.11               0.               0.0           2.37          0.0          -1.56
 MAY         2.73           1.01               0.               0.0           3.33          0.0           0.41
 JUNE        4.63           1.30               0.               0.0           3.70          0.0           2.23
 JULY        3.25           1.53               0.               0.0           4.23          0.0           0.54
 AUG.        2.08           0.95               0.               0.0           3.57          0.0          -0.53
 SEPT        2.55           0.62               0.               0.0           2.24          0.0           0.92
 OCT.        0.12           0.0                0.               0.0           1.50          0.0          -1.38
 NOV.        0.05           0.0                0.               0.0           0.63          0.0          -0.58
 DEC.        0.30           0.0                0.               0.0           0.24          0.0           0.06
 TOT.       19.77           7.25               0.               0.0          21.93          0.0           5.08
                          WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1965
------------------------------------------------------------------------------------------------------
                  INPUTS                                          OUTPUTS
         ----------------------------       ------------------------------------------------------
MONTH    PRECIPITATION   IRRIGATION     INTERCEPTION  SURFACE RUNOFF   PERCOLATION      AET     CHANGE IN SM
 JAN.        0.82           0.0             0.13          0.0             0.0           0.22       -0.09
 FEB.        3.14           0.0             0.37          0.0             0.0           0.23        1.50
 MAR.        1.66           0.0             0.43          0.10            0.0           0.51        2.22
 APR.        1.16           0.0             0.33          0.17            0.0           1.43       -0.77
 MAY         4.56           0.0             0.70          0.95            0.0           1.81        1.10
 JUNE        7.73           0.0             1.31          2.00            0.0           3.62        0.80
 JULY        5.42           0.0             1.04          0.52            0.0           5.34       -1.48
 AUG.        3.47           0.0             0.40          0.03            0.0           4.66       -1.62
 SEPT        4.25           0.0             0.65          0.06            0.0           2.50        1.04
 OCT.        0.20           0.0             0.10          0.0             0.0           0.90       -0.80
 NOV.        0.09           0.0             0.09          0.0             0.0           0.75       -0.75
 DEC.        0.50           0.0             0.19          0.0             0.0           0.25        0.06
 TOT.       33.00           0.0             5.74          3.83            0.0          22.22        1.21
PERCENT OF WASTEWATER CONTROLLED=    100.00

POTENTIAL DISPOSAL DAYS=   0

PACK ON DECEMBER 31 = 0.0                CHANGE IN SNOW STORAGE= 0.0

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED =  26.26

ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 35.23

ESTIMATED LAKE EVAPORATION, INCHES = 38.45

MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.57 OR 84.7 % OF ANNUAL
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                          ***** ANNUAL SUMMARY *****

         WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1966
--------------------------------------------------------------------------------------------------------------
                  INFLOWS                                              OUTFLOWS
         ------------------------------                    ------------------------------------------
MONTH    PRECIPITATION   FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.   SURFACE EVAP.   DISCHARGE   CHANGE IN VOL.
 JAN.        0.07            0.0                0.               0.0             0.07           0.0          -0.00
 FEB.        1.11            0.50               0.               0.0             0.20           0.0           1.41
 MAR.        0.13            0.0                0.               0.0             1.26           0.0          -1.13
 APR.        0.45            0.0                0.               0.0             2.14           0.0          -1.69
 MAY         0.10            0.0                0.               0.0             3.25           0.0          -3.16
 JUNE        2.07            0.79               0.               0.0             3.84           0.0          -0.98
 JULY        2.10            0.47               0.               0.0             4.49           0.0          -1.22
 AUG.        2.29            0.91               0.               0.0             3.42           0.0          -0.22
 SEPT        1.74            0.60               0.               0.0             2.32           0.0           0.02
 OCT.        0.50            0.0                0.               0.0             1.44           0.0          -0.94
 NOV.        0.04            0.00               0.               0.0             0.40           0.0          -0.36
 DEC.        0.77            0.0                0.               0.0             0.01           0.0           0.76
 TOT.       11.37            3.26               0.               0.0            22.83           0.0          -8.19
                    WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1966
--------------------------------------------------------------------------------------------------------------
                       INPUTS                                      OUTPUTS
            ---------------------------        ----------------------------------------------------
MONTH      PRECIPITATION   IRRIGATION   INTERCEPTION   SURFACE RUNOFF   PERCOLATION      AET      CHANGE IN SM
 JAN.          0.11           0.0           0.09            0.0             0.0          0.15        -0.13
 FEB.          1.86           0.0           0.20            0.22            0.0          0.50         0.93
 MAR.          0.22           0.0           0.14            0.0             0.0          0.50        -0.42
 APR.          0.75           0.0           0.37            0.0             0.0          0.35         0.03
 MAY           0.16           0.0           0.14            0.0             0.0          1.29        -1.27
 JUNE          3.45           0.0           0.47            0.03            0.0          2.42         0.52
 JULY          3.51           0.0           0.75            0.0             0.0          3.21        -0.45
 AUG.          3.83           0.0           0.50            0.04            0.0          3.36        -0.07
 SEPT          2.90           0.0           0.47            0.06            0.0          2.38        -0.01
 OCT.          0.84           0.0           0.16            0.0             0.0          0.66         0.02
 NOV.          0.07           0.0           0.07            0.0             0.0          0.62        -0.62
 DEC.          1.29           0.0           0.02            0.0             0.0          0.19        -0.19
 TOT.         18.99           0.0           3.38            0.36            0.0         15.64        -1.66
  PERCENT OF WASTEWATER CONTROLLED=     100.00

  POTENTIAL DISPOSAL DAYS=    0

  PACK ON DECEMBER 31 = 1.27              CHANGE IN SNOW STORAGE= 1.27

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  24.81

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 37.36

  ESTIMATED LAKE EVAPORATION, INCHES = 40.59

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.18 OR 81.7 % OF ANNUAL
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                              ***** ANNUAL SUMMARY *****

               WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1967
----------------------------------------------------------------------------------------------------------
                   INFLOWS
         ----------------------------                                  OUTFLOWS
                                                           -----------------------------------------
MONTH   PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE    CHANGE IN VCL.
 JAN.       0.21           0.54               0.                0.0            0.07          0.0            0.68
 FEB.       0.15           0.00               0.                0.0            0.22          0.0           -0.06
 MAR.       0.61           0.0                0.                0.0            1.46          0.0           -0.84
 APR.       2.51           0.55               0.                0.0            2.33          0.0            0.73
 MAY        1.51           0.04               0.                0.0            2.58          0.0           -1.03
 JUNE       5.88           2.36               0.                0.0            3.64          0.0            4.61
 JULY       1.97           0.26               0.                0.0            4.04          0.0           -1.81
 AUG.       1.59           0.62               0.                0.0            3.43          0.0           -1.22
 SEPT       3.94           1.50               0.                0.0            2.26          0.0            3.18
 OCT.       0.71           0.0                0.                0.0            1.38          0.0           -0.68
 NOV.       0.24           0.0                0.                0.0            0.48          0.0           -0.24
 DEC.       0.96           0.07               0.                0.0            0.10          0.0            0.93
 TOT.      20.28           5.93               0.                0.0           21.98          0.0            4.23
                          WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1967
----------------------------------------------------------------------------------------------------------
                        INPUTS                                  OUTPUTS
            ----------------------------    -------------------------------------------------
MONTH      PRECIPITATION    IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCOLATION        AET      CHANGE IN SM
 JAN.          0.35            0.0           0.23           0.0            0.0            0.30         1.09
 FEB.          0.25            0.0           0.20           0.0            0.0            0.20        -0.15
 MAR.          1.02            0.0           0.37           0.0            0.0            0.26         0.39
 APR.          4.19            0.0           0.98           0.42           0.0            1.22         1.57
 MAY           2.52            0.0           0.97           0.01           0.0            1.44         0.10
 JUNE          9.82            0.0           1.16           3.04           0.0            3.43         2.19
 JULY          3.29            0.0           0.93           0.0            0.0            5.18        -2.82
 AUG.          2.65            0.0           0.56           0.03           0.0            3.87        -1.81
 SEPT          6.57            0.0           1.01           0.78           0.0            2.28         2.50
 OCT.          1.18            0.0           0.60           0.03           0.0            0.74        -0.19
 NOV.          0.40            0.0           0.18           0.00           0.0            0.84        -0.62
 DEC.          1.61            0.0           0.25           0.0            0.0            0.33         0.63
 TOT.         33.85            0.0           7.43           4.31           0.0           20.10         2.89
  PERCENT OF WASTEWATER CONTROLLED=    100.00

  POTENTIAL DISPOSAL DAYS=   0

  PACK ON DECEMBER 31 = 0.40              CHANGE IN SNOW STORAGE=-0.87

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SCIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  13.26

  ESTIMATED POTENTIAL EVAPOTRANSPIRATICN, INCHES = 36.37

  ESTIMATED LAKE EVAPORATION, INCHES = 39.66

  MAY - OCTOBER LAKE EVAPURATION, INCHES = 31.40 OR 79.2 % OF ANNUAL
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                              ***** ANNUAL SUMMARY *****
              WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1968
-------------------------------------------------------------------------------------------------------
               INFLOWS                                              OUTFLOWS
       ----------------------------                   -----------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE  CHANGE IN VOL.
 JAN.      0.08          0.12              0.               0.0           0.02          0.0          0.19
 FEB.      0.34          0.0               0.               0.0           0.16          0.0          0.18
 MAR.      0.04          0.12              0.               0.0           1.21          0.0         -1.05
 APR.      2.29          0.39              0.               0.0           2.28          0.0          0.40
 MAY       1.50          0.02              0.               0.0           2.97          0.0         -1.44
 JUNE      2.58          1.14              0.               0.0           3.83          0.0         -0.11
 JULY      2.75          0.74              0.               0.0           4.20          0.0         -0.71
 AUG.      5.63          2.30              0.               0.0           3.57          0.0          4.36
 SEPT      2.65          0.92              0.               0.0           2.38          0.0          1.19
 OCT.      1.78          0.79              0.               0.0           1.48          0.0          1.09
 NOV.      0.64          0.19              0.               0.0           0.42          0.0          0.41
 DEC.      1.04          0.0               0.               0.0           0.10          0.0          0.94
 TOT.     21.33          6.73              0.               0.0          22.61          0.0          5.45
                       WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1968
-------------------------------------------------------------------------------------------------------
               INPUTS                                      OUTPUTS
       --------------------------  ------------------------------------------------------
MONTH  PRECIPITATION  IRRIGATION  INTERCEPTION  SURFACE RUNOFF  PERCOLATION   AET   CHANGE IN SM
 JAN.      0.14          0.0          0.16           0.0            0.0        0.31      0.08
 FEB.      0.56          0.0          0.19           0.0            0.0        0.63     -0.26
 MAR.      0.06          0.0          0.06           0.0            0.0        0.82     -0.82
 APR.      3.83          0.0          0.79           0.13           0.0        1.87      1.04
 MAY       2.51          0.0          0.91           0.00           0.0        1.39      0.20
 JUNE      4.31          0.0          0.51           1.39           0.0        3.31     -0.90
 JULY      4.59          0.0          0.91           0.00           0.0        3.70     -0.02
 AUG.      9.40          0.0          0.97           1.97           0.0        4.99      1.47
 SEPT      4.43          0.0          0.50           0.96           0.0        3.16     -0.19
 OCT.      2.97          0.0          0.29           0.80           0.0        1.04      0.84
 NOV.      1.07          0.0          0.41           0.12           0.0        0.52      0.03
 DEC.      1.74          0.0          0.10           0.0            0.0        0.22     -0.05
 TOT.     35.61          0.0          5.79           5.38           0.0       21.96      1.41
PERCENT OF WASTEWATER CONTROLLED=    100.00

POTENTIAL DISPOSAL DAYS=   0

PACK ON DECEMBER 31 = 1.47               CHANGE IN SNOW STORAGE= 1.07

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED =  24.97

ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 37.04

ESTIMATED LAKE EVAPORATION, INCHES = 39.92

MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.54 OR 81.5 % OF ANNUAL
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                              ***** ANNUAL SUMMARY *****

              WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1969

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                 INFLOWS                                                    OUTFLOWS
       -----------------------------                       ----------------------------------------
MONTH  PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE     CHANGE IN VCL.
 JAN.      0.35           0.62                0.                0.0           0.01          0.0             0.96
 FEB.      0.92           0.0                 0.                0.0           0.0           0.0             0.92
 MAR.      1.37           1.37                0.                0.0           0.54          0.0             2.20
 APR.      1.59           0.54                0.                0.0           2.37          0.0            -0.25
 MAY       3.92           1.11                0.                0.0           3.20          0.0             1.83
 JUNE      1.41           0.20                0.                0.0           3.66          0.0            -2.05
 JULY      5.77           2.53                0.                0.0           4.35          0.0             3.94
 AUG.      0.92           0.0                 0.                0.0           3.62          0.0            -2.70
 SEPT      0.95           0.10                0.                0.0           2.51          0.0            -1.45
 OCT.      2.22           0.33                0.                0.0           1.33          0.0             1.22
 NOV.      0.03           0.0                 0.                0.0           0.61          0.0            -0.58
 DEC.      0.37           0.04                0.                0.0           0.09          0.0             0.32
 TOT.     19.83           6.84                0.                0.0          22.32          0.0             4.35
                         WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1969
------------------------------------------------------------------------------------------------------
                      INPUTS                                      OUTPUTS
            ---------------------------   -------------------------------------------------------
MONTH       PRECIPITATION    IRRIGATION   INTERCEPTION  SURFACE RUNOFF   PERCOLATION        AET       CHANGE IN SM
 JAN.           0.59            0.0           0.19           0.02            0.0            0.26          0.51
 FEB.           1.54            0.0           0.37           0.00            0.0            0.39          0.67
 MAR.           2.29            0.0           0.50           0.57            0.0            0.85          1.55
 APR.           2.65            0.0           0.57           0.24            0.44           1.56         -0.17
 MAY            6.55            0.0           1.08           0.87            1.83           1.73          1.04
 JUNE           2.35            0.0           0.72           0.0             0.16           3.54         -2.07
 JULY           9.63            0.0           0.83           1.80            0.0            6.58          0.42
 AUG.           1.54            0.0           0.64           0.0             0.0            5.48         -4.58
 SEPT           1.59            0.0           0.42           0.0             0.0            1.94         -0.77
 OCT.           3.71            0.0           0.90           0.01            0.0            0.41          2.39
 NOV.           0.05            0.0           0.05           0.0             0.0            0.87         -0.87
 DEC.           0.62            0.0           0.21           0.0             0.0            0.26         -0.10
 TOT.          33.11            0.0           6.49           3.51            2.44          23.85         -1.96
  PERCENT OF WASTEWATER CONTROLLED=    100.00

  POTENTIAL DISPOSAL DAYS=   0

  PACK ON DECEMBER 31 = 0.25              CHANGE IN SNOW STORAGE=-1.22

  INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

  PERCENT OF MAXIMUM POND VOLUME REQUIRED =  45.29

  ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 35.26

  ESTIMATED LAKE EVAPORATION, INCHES = 38.74

  MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.42 OR 83.7 % OF ANNUAL
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                                   ***** ANNUAL SUMMARY *****
                  WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1970
-----------------------------------------------------------------------------------------------------------
               INFLOWS
        ------------------------------                                   OUTFLOWS
MONTH   PRECIPITATION  FEEDLOT RUNOFF  NO. DISPOSAL DAYS  ------------------------------------------
                                                          DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VCL.
 JAN.       0.07           0.05              0.               0.0            0.11          0.0          0.00
 FEB.       0.03           0.0               0.               0.0            0.47          0.0         -0.44
 MAR.       0.74           0.01              0.               0.0            0.60          0.0          0.15
 APR.       1.71           0.40              0.               0.0            2.17          0.0         -0.05
 MAY        2.40           0.67              0.               0.0            3.43          0.0         -0.37
 JUNE       2.80           0.99              0.               0.0            3.89          0.0         -0.10
 JULY       0.60           0.05              0.               0.0            4.36          0.0         -3.71
 AUG.       1.38           0.54              0.               0.0            3.84          0.0         -1.91
 SEPT       4.56           1.99              0.               0.0            2.40          0.0          4.15
 OCT.       1.19           0.36              0.               0.0            1.34          0.0          0.21
 NOV.       0.58           0.09              0.               0.0            0.44          0.0          0.23
 DEC.       0.15           0.0               0.               0.0            0.14          0.0          0.01
 TOT.      16.21           5.15              0.               0.0           23.18          0.0         -1.83
                      WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1970
-----------------------------------------------------------------------------------------------------------
               INPUTS
        ----------------------------                         OUTPUTS
MONTH   PRECIPITATION  IRRIGATION  -----------------------------------------------------------
                                   INTERCEPTION  SURFACE RUNOFF  PERCOLATION     AET    CHANGE IN SM
 JAN.       0.11          0.0          0.10           0.0            0.0         0.24       0.02
 FEB.       0.05          0.0          0.05           0.0            0.0         0.30      -0.30
 MAR.       1.24          0.0          0.49           0.0            0.0         0.22       0.31
 APR.       2.86          0.0          0.49           0.48           0.0         1.34       0.78
 MAY        4.00          0.0          0.81           0.59           0.0         1.69       0.91
 JUNE       4.67          0.0          0.72           0.71           0.0         3.69      -0.44
 JULY       1.00          0.0          0.29           0.0            0.0         3.62      -2.91
 AUG.       2.31          0.0          0.34           0.02           0.0         2.08      -0.12
 SEPT       7.62          0.0          0.93           1.22           0.0         2.67       2.81
 OCT.       1.98          0.0          0.41           0.15           0.0         0.87       0.55
 NOV.       0.97          0.0          0.22           0.00           0.0         0.71       0.04
 DEC.       0.25          0.0          0.02           0.0            0.0         0.59      -0.45
 TOT.      27.06          0.0          4.87           3.16           0.0        18.02       1.19
PERCENT OF WASTEWATER CONTROLLED=    100.00

POTENTIAL DISPOSAL DAYS=    0

PACK ON DECEMBER 31 = 0.08                    CHANGE IN SNOW STORAGE=-0.17

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED =  36.80

ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 37.71

ESTIMATED LAKE EVAPORATION, INCHES = 40.41

MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.58 OR 83.1 % OF ANNUAL
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                              ***** ANNUAL SUMMARY *****
                 WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1971
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                    INFLCWS                                                   OUTFLCWS
        ---------------------------                         ----------------------------------------
MONTH   PRECIPITATION  FEEDLOT RUNOFF   NO. DISPOSAL DAYS   DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE    CHANGE IN VOL.
 JAN.        0.80           0.0                0.                0.0            0.0          0.0           0.80
 FEB.        1.75           0.92               0.                0.0            0.15         0.0           2.52
 MAR.        0.71           0.90               0.                0.0            0.78         0.0           0.83
 APR.        0.54           0.0                0.                0.0            2.38         0.0          -1.84
 MAY         5.43           2.75               0.                0.0            3.09         0.0           5.08
 JUNE        1.98           0.65               0.                0.0            4.02         0.0          -1.39
 JULY        3.35           1.16               0.                0.0            4.14         0.0           0.38
 AUG.        0.51           0.03               0.                0.0            3.66         0.0          -3.12
 SEPT        0.72           0.02               0.                0.0            2.49         0.0          -1.74
 OCT.        3.34           1.46               0.                0.0            1.50         0.0           3.31
 NOV.        1.81           0.65               0.                0.0            0.44         0.0           2.02
 DEC.        0.64           0.20               0.                0.0            0.04         0.0           0.81
 TOT.       21.59           8.75               0.                0.0           22.68         0.0           7.65
                       WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1971
------------------------------------------------------------------------------------------------------------------
                    INPUTS                                     OUTPUTS
        ---------------------------  ------------------------------------------------------
MONTH   PRECIPITATION   IRRIGATION   INTERCEPTION  SURFACE RUNOFF  PERCOLATION      AET      CHANGE IN SM
 JAN.        1.33          0.0           0.31          0.0            0.0           0.24         0.79
 FEB.        2.93          0.0           0.36          0.13           0.0           0.34         0.73
 MAR.        1.19          0.0           0.55          0.16           0.0           0.97         0.96
 APR.        0.90          0.0           0.41          0.0            0.0           0.95        -0.46
 MAY         9.06          0.0           0.89          3.04           1.25          1.66         2.22
 JUNE        3.31          0.0           0.57          0.68           0.18          3.86        -1.98
 JULY        5.60          0.0           1.12          0.51           0.0           6.22        -2.25
 AUG.        0.85          0.0           0.32          0.0            0.0           3.14        -2.61
 SEPT        1.20          0.0           0.33          0.0            0.0           1.08        -0.21
 OCT.        5.58          0.0           0.46          0.86           0.0           0.52         3.75
 NOV.        3.02          0.0           0.39          0.32           0.0           0.63         1.51
 DEC.        1.07          0.0           0.28          0.16           0.0           0.44         0.37
 TOT.       36.04          0.0           5.99          5.86           1.43         20.05         2.79
PERCENT OF WASTEWATER CONTROLLED=    100.00

POTENTIAL DISPOSAL DAYS=    0

PACK ON DECEMBER 31 = 0.0              CHANGE IN SNOW STORAGE=-0.08

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED =  51.76

ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 36.C9

ESTIMATED LAKE EVAPORATION, INCHES = 39.22

MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.66 OR 83.3 % CF ANNUAL
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***** ANNUAL SUMMARY *****

WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1972

	INFLOWS			OUTFLOWS			
MONTH	PRECIPITATION	FEEDLOT RUNOFF	NO. DISPOSAL DAYS	DISPOSAL VOL.	SURFACE EVAP.	DISCHARGE	CHANGE IN VCL.
JAN.	0.10	0.29	0.	0.0	0.04	0.0	0.35
FEB.	0.26	0.08	0.	0.0	0.32	0.0	0.03
MAR.	0.31	0.0	0.	0.0	1.44	0.0	-1.12
APR.	1.77	0.46	0.	0.0	2.31	0.0	-0.08
MAY	4.30	1.29	0.	0.0	3.22	0.0	2.38
JUNE	1.58	0.77	0.	0.0	3.94	0.0	1.59
JULY	2.41	0.44	0.	0.0	4.20	0.0	1.35
AUG.	4.72	2.19	0.	0.0	3.58	0.0	3.33
SEPT	1.11	0.11	0.	0.0	2.47	0.0	-1.25
OCT.	1.58	0.38	0.	0.0	1.35	0.0	0.62
NOV.	2.51	0.85	0.	0.0	0.28	0.0	3.08
DEC.	0.80	0.53	0.	0.0	0.14	0.0	1.18
TOT.	21.46	7.40	0.	0.0	23.29	0.0	5.57

WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1972

	INPUTS		OUTPUTS				
MONTH	PRECIPITATION	IRRIGATION	INTERCEPTION	SURFACE RUNOFF	PERCOLATION	AET	CHANGE IN SM
JAN.	0.17	0.0	0.12	0.0	0.0	0.27	-0.23
FEB.	0.44	0.0	0.13	0.01	0.0	0.69	-0.37
MAR.	0.52	0.0	0.22	0.0	0.0	0.66	-0.36
APR.	2.96	0.0	0.52	0.33	0.0	0.61	1.50
MAY	7.18	0.0	1.11	1.96	1.62	1.72	0.77
JUNE	2.64	0.0	0.37	0.08	0.19	3.77	-1.77
JULY	4.02	0.0	0.85	0.0	0.0	6.09	-2.92
AUG.	7.88	0.0	0.81	1.50	0.0	4.85	0.71
SEPT	1.85	0.0	0.40	0.12	0.0	2.89	-1.55
OCT.	2.64	0.0	0.61	0.18	0.0	0.72	1.13
NOV.	4.19	0.0	0.56	0.91	0.0	0.40	2.31
DEC.	1.33	0.0	0.22	0.00	0.0	0.14	0.34
TOT.	35.82	0.0	5.92	5.10	1.81	22.80	-0.44

PERCENT OF WASTEWATER CONTROLLED= 100.00

POTENTIAL DISPOSAL DAYS= 0

PACK ON DECEMBER 31 = 0.63 CHANGE IN SNOW STORAGE= 0.63

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED = 62.63

ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 36.48

ESTIMATED LAKE EVAPORATION, INCHES = 40.10

MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.28 OR 80.5 % OF ANNUAL

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                    ***** ANNUAL SUMMARY *****

      WATER ACCOUNT FOR STORAGE FACILITY (IN INCHES OVER DISPOSAL AREA) - 1973
------------------------------------------------------------------------------------------------------------------
             INFLOWS
      ---------------------------                                       OUTFLOWS
MONTH PRECIPITATION FEEDLOT RUNOFF  NO. DISPOSAL DAYS  -----------------------------------------
                                                       DISPOSAL VOL.  SURFACE EVAP.  DISCHARGE   CHANGE IN VOL.
 JAN.     0.77          0.03              0.               0.0            0.15          0.0          0.65
 FEB.     0.33          0.08              0.               0.0            0.31          0.0          0.10
 MAR.     4.05          1.27              0.               0.0            1.54          0.0          3.77
 APR.     1.58          0.20              0.               0.0            2.24          0.0         -0.46
 MAY      2.80          0.79              0.               0.0            3.19          0.0          0.40
 JUNE     1.06          0.18              0.               0.0            4.05          0.0         -2.81
 JULY     5.15          2.40              0.               0.0            4.35          0.0          3.21
 AUG.     1.00          0.02              0.               0.0            3.79          0.0         -2.78
 SEPT     6.67          3.24              0.               0.0            2.35          0.0          7.57
 OCT.     3.24          2.07              0.               0.0            1.55          0.0          3.76
 NOV.     0.63          0.05              0.               0.0            0.64          0.0          0.04
 DEC.     1.75          0.22              0.               0.0            0.05          0.0          1.92
 TOT.    29.03         10.55              0.               0.0           24.22          0.0         15.37
                   WATER BALANCE (INCHES) IN THE DISPOSAL AREA - 1973
------------------------------------------------------------------------------------------------------------------
              INPUTS
      ----------------------------                         OUTPUTS
MONTH                             ---------------------------------------------------------------
      PRECIPITATION  IRRIGATION  INTERCEPTION  SURFACE RUNOFF  PERCOLATION      AET      CHANGE IN SM
 JAN.     1.29          0.0          0.43          0.06           0.0          0.22          1.04
 FEB.     0.55          0.0          0.20          0.01           0.0          0.55         -0.04
 MAR.     6.76          0.0          1.17          1.70           1.88         1.18          0.84
 APR.     2.64          0.0          0.83          0.08           0.40         1.95         -0.62
 MAY      4.67          0.0          0.78          1.05           1.12         1.68          0.03
 JUNE     1.77          0.0          0.54          0.18           0.0          3.83         -2.79
 JULY     8.60          0.0          0.74          1.16           0.0          6.44          0.25
 AUG.     1.67          0.0          0.57          0.0            0.0          4.54         -3.44
 SEPT    11.14          0.0          1.28          3.39           0.0          2.42          4.05
 OCT.     5.41          0.0          0.37          3.29           0.0          1.08          0.67
 NOV.     1.05          0.0          0.23          0.0            0.0          0.66          0.16
 DEC.     2.92          0.0          0.16          0.00           0.0          0.32          0.33
 TOT.    48.47          0.0          7.30         10.92           3.41        24.89          0.48
PERCENT OF WASTEWATER CONTROLLED=    100.00

POTENTIAL DISPOSAL DAYS=   0

PACK ON DECEMBER 31 = 2.10                CHANGE IN SNOW STORAGE= 1.48

INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN   SOIL MOISTURE

PERCENT OF MAXIMUM POND VOLUME REQUIRED =  99.39

ESTIMATED POTENTIAL EVAPOTRANSPIRATION, INCHES = 36.80

ESTIMATED LAKE EVAPORATION, INCHES = 41.08

MAY - OCTOBER LAKE EVAPORATION, INCHES = 32.71 OR 79.6 % OF ANNUAL
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STATION:   BELLEVILLE, KANSAS           1949  TO  1973


CRITICAL EVENT- 5.10 INCHES


FEEDLOT AREA- 40.00 ACRES


POND VARIABLES:

               (A) BASE DIMENSION-- 700.00  FEET BY 2800.00  FEET

               (B) SIDE SLOPE--   RUN: RISE = 3.0 : 1

               (C) MAXIMUM DEPTH--   6.00  FEET

               (D) MAXIMUM POND VOLUME--    3344.52 ACRE-INCHES

               (E) DIRECT RECEIVING AREA (FOR PRECIPITATION) --     47.92 ACRES


DISPOSAL AREA VARIABLES:

               (A) DISPOSAL AREA--    80.00  ACRES

               (B) CROP--  CORN

               (C) SOIL TYPE--    5   (SCS) SOIL TYPE

               (D) DISPOSAL RATE--   0.50  INCHES/DAY ON DISPOSAL DAYS

               (E) IRRIGATION MANAGEMENT--   IRRIGATION BELOW   0.0   AVAILABLE MOISTURE


                                  ***** FINAL SUMMARY *****
 METEOROLOGICAL SUMMARY

                AVERAGE ANNUAL LAKE EVAPORATION= 40.55 INCHES

                AVERAGE MAY - OCTOBER LAKE EVAPORATION, INCHES = 33.24 OR 82.0 % OF ANNUAL
```

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            AVERAGE ANNUAL PRECIPITATION= 30.03 INCHES
            AVERAGE ANNUAL POTENTIAL EVAPOTRANSPIRATION= 37.12 INCHES
            PRECIPITATION RANGE= 32.57 INCHES   (FROM A LOW OF 15.90 INCHES  TO A HIGH OF  48.47 INCHES)
SUMMARY OF POND OPERATIONS
            NO. OF YEARS HAVING A DISCHARGE=     0
            AVERAGE NO. OF DISCHARGES / YEAR HAVING A DISCHARGE=  0.0
            AVERAGE DISCHARGE=  0.0  ACRE-INCHES
            AVERAGE PERCENT OF WASTEWATER CONTROLLED=100.00
            TOTAL DISCHARGE VOLUME=     0.0  ACRE-INCHES
            TOTAL NO. OF DISCHARGES=  0.
            MAXIMUM DISCHARGE=  0.0  ACRE-INCHES
SUMMARY OF DISPOSAL AREA
            AVERAGE ANNUAL DEPTH OF WASTEWATER APPLIED=  0.0  INCHES OVER ENTIRE DISPOSAL AREA
            AVERAGE ANNUAL DISPOSAL AREA RUNOFF=  3.55 INCHES
            AVERAGE ANNUAL DISPOSAL AREA PERCOLATION=  0.51 INCHES
            AVERAGE ANNUAL NO. OF DISPOSAL DAYS=   0.0
```

APPENDIX C

REGRESSION ANALYSES

Many climatological factors contribute to the retention pond design for either irrigation or pure evaporation disposal. Stepwise deletion multiple regressions were run with various combinations and transformations of several climatological variables in order to isolate the most important variables. The design equations (Figures 6 and 7) were eventually chosen on the basis of degree of correlation, simplicity of use, and ease of obtaining the climatological variable or variables in question. Table C-1 is a list of the climatological variables used in the equations. The availability of the data is an important factor. Independent variables that are derived from the computer model are less desirable than those that are derived from readily available published information.

TABLE C-1. GLOSSARY OF CLIMATOLOGICAL VARIABLES USED IN REGRESSION ANALYSES

Variable name	Definition
PONVOL	Pond volume for 100 percent control for 40-acre feedlot under standard conditions (acre-inches). Dependent variable in regression for irrigation disposal. (Fig. 5 and 6).
PV40	Pond volume for 100 percent control for 40-acre feedlot under standard conditions per acre of feedlot (ac-in/ac). Dependent variable in regression for irrigation disposal.
SURF	Pond surface area for 40-acres feedlot under standard conditions (acres). Primary dependent variable for evaporation disposal. (Fig. 7).
P25	25 year-24 hour storm (inches) (Fig. 5).
MD	Moisture deficit = Mean annual evaporation--mean annual precipitation (inches) (Fig. 6 and 7).
RAIN	Mean annual precipitation (inches)
MO2	Sum of mean monthly precipitation for the two consecutive months having the largest total rainfall (inches)
EVAP	Mean annual lake evaporation

(continued)

TABLE C-1 (Continued)

Variable name	Definition
MP2CM	Maximum precipitation for two consecutive months for simulation period.
CI	Transformed variable = MD/P25 (inches/inch)
PREVAP	Transformed variable = RAIN/EVAP (Inches/inch)
CI1	Transformed variable = Log[(MD+20)/P25]
CI2	Transformed variable = PREVAP * P25 (inches)
CI3	Transformed variable = (MD/P25)* PREVAP (inches)
CI4	Transformed variable = P25/PREVAP (inches/inch)

Table C-2 contains a list of all regressions performed. Equations 15a and 26 were chose as best representing the desired result for simplified design for irrigation disposal and evaporation, respectively. Unless otherwise noted, the regressions are significant at the 5 percent level.

TABLE C-2. LIST OF STEPWISE MULTIPLE REGRESSIONS

No.	Equation	R^2	Comment
1.	Log PV40 = 0.956 + 0.0605 P25 - 0.0134 MD	0.850	
2.	Log PV40 = 1.290 - 0.0608 CI	0.851	Las Vegas excluded
3.	PV40 = f(P25,MD,PREVAP)	--	PREVAP not significant. Backward elimination results in Eq. (1)
4.	Log PV40 = 0.806 + 0.0792 P25 - 0.0118 MD	0.884	Wooster, Ohio excluded
5.	Log PV40 = 0.972 + 0.0576 P25 - 0.0127 MD - 0.00244 CI	0.850	CI not significant
6.	Log PV40 = 0.944 + 0.0650 P25 - 0.0143 MD	0.850	Las Vegas excluded
7.	Log PV40 = 1.861 - 1.040 CI1	0.829	
8.	Log PV40 = 0.046 - 0.0464 CI	0.793	
9.	PONVOL = 566.2 + 57.0 P25 - 20.8 MD + 28.1 CI	0.509	Wooster excluded P25 and CI not significant
10.	Log PV40 = 1.243 - 0.0197 CI4	0.503	
11.	PONVOL = 747.5 + 22.6 P25 - 13.8 MD	0.494	P25 not significant
12.	Log PV40 = 1.189 - 0.176 CI3	0.483	
13.	Log PV40 = 0.358 + 0.973 PREVAP	0.781	
14.	Log PV40 = 1.246 - 0.0486 CI	0.785	
15a.	Log PONVOL = 2.910 - 0.0150 MD	0.803	Used in Fig. 6
15b.	Log PONVOL = 1.811 + 0.148 P25	0.326	Used in Fig. 5
15c.	Log PONVOL = 4.373 - 0.0607 $(\text{PREVAP})^{-1}$	0.518	
16.	Log SURF = -0.508 + 0.153 P25 + 2.840 PREVAP - 0.191 CI2	0.964	
17.	Log SURF = 0.275 + 0.0511 P25 - 0.0174 CI + + 1.478 PREVAP	0.962	
18.	Log SURF = -0.0682 - 0.0267 MP2CM + 1.622 PREVAP	0.960	
19.	Log SURF = 1.061 + 0.116 P25 - 0.0185 MD	0.929	
20.	Log SURF = 0.556 - 0.0444 MD + 0.0357 EVAP	0.940	
21.	Log SURF = 1.277 + 0.102 P25 - 0.0160 MD - 0.0954 CI2 - 0.110 CI3	0.905	
22.	Log SURF = 1.595 - 0.0670 CI	0.833	
23.	Log SURF = 1.814 - 0.0234 MD	0.826	
24.	Log SURF = -0.137 + 0.228 P25	0.542	
25.	Log SURF = 1.507 - 0.228 CI3	0.140	
26.	Log SURF = 0.091 + 2.166 PREVAP	0.916	Used in Fig. 7

APPENDIX D

STATE-OF-THE-ART OF MODELLING FEEDLOT RUNOFF QUALITY

by

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ABSTRACT

The purpose of this work is to summarize the state-of-the-art in modeling water quality of feedlot runoff, retention basin effluent, and runoff from fields where effluent has been applied. Available water quality models and data are reviewed. Some models for specific water quality variables are available for modelling feedlot runoff, runoff from fields, and transport through soils; however, further modelling and additional data are needed to develop useful water quality models for management and control of feedlot runoff.

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INTRODUCTION

Continuous watershed modelling of feedlot runoff, retention basin operation, and land disposal (Anschutz, et al., 1977, Wensink and Miner, 1976, Zovne, et al., 1977) has provided valuable information which can be useful in both the design and management of retention basins and associated facilities for feedlot runoff. The water quality of feedlot runoff, retention basin effluent, and runoff from agricultural lands where the effluent is distributed is also important and should be considered in feedlot runoff management and control. The purpose of this work is to summarize the state-of-the-art in modelling the water quality of feedlot runoff, retention basin effluent, and runoff where effluent has been applied. Both groundwater and stream water quality are to be considered. A general goal of this work is to assemble comprehensive information that can be used in efforts to include water quality in continuous watershed modelling of feedlot runoff.

Five specialists (S. Y. Chiu, James Davidson, L. T. Fan, J. R. Miner, and William Powers) were asked to prepare working papers on the state-of-the-art in their area of water quality specialization. On December 13 and 14, 1976, a meeting of the specialists and Lynn Shuyler, Jerome Zovne, James Koelliker, and L. E. Erickson was held. The state-of-the-art was reviewed and some of the problems associated with feedlot runoff water quality modelling were identified and discussed.

CONCLUSIONS

Considerable effort has been devoted to the characterization of runoff from cattle feedlots; however, the water quality of runoff shows great variability. The chemical and biochemical reactions which occur on the feedlot surface, the intensity of the rainfall, the soil temperature, and the lot moisture condition prior to the rainfall event all appear to influence the water quality of runoff. The slope of the lot is also important.

Models have been developed to predict the chemical oxygen demand and the Kjeldahl nitrogen in runoff from cattle feedlots. Further work to extend this modelling to include other variables such as the various forms of nitrogen is needed.

Water quality in retention ponds depends upon the quality of the feedlot runoff which enters, sedimentation, evaporation, ammonia desorption, and the chemical and biochemical transformations which occur in the basin. Anaerobic conditions are present in most of the basin. The forms of nitrogen in the basin are important because the ammonium ion is absorbed by soil while the nitrate ion has a tendencey to remain in solution. Reduction in biochemical oxygen demand is also important because soluble organic materials can be transported from the land where basin effluent is distributed. Mathematical models for the various forms of nitrogen and the biochemical oxygen demand need to be developed; very little attention has been directed to modelling the retention basin.

Dissolved solids also need to be modelled in the retention basin. Evaporation significantly affects the concentration of dissolved solids.

Some results have been reported on the water quality of runoff from non-point sources such as fields where retention basin effluent has been applied. The suspended solids or sediment which is washed from the field is responsible for a significant portion of the pollutants from non-point sources which enter streams. Consideration should be given to the quality of the field cover where retention basin effluent is applied.

Chronic wet periods where a series of rainfall events follow each other closely must be considered in the management of water quality associated with feedlot runoff. Further research is needed to determine the best management practice under these conditions.

Models of the movement of inorganic ions in soils are available. In some areas of the country consideration must be given to the effect upon groundwater of distributing retention basin effluent onto land; however, in many locations this is not a problem.

STATE-OF-THE-ART REVIEW

Water quality aspects of feedlot runoff can be divided geographically into four parts: the feedlot and runoff from it, the retention basin and effluent from it, the field surface where effluent is distributed, and the region below the soil surface where feedlot effluents are present. Water quality is important because of possible pollution of streams and groundwater, but also because of the need to know what is being distributed to the land surface.

Stream water quality models can be used to determine the effects on stream water quality of runoff from fields where retention basin effluents have been distributed. This field runoff may be from rainfall events or during chronic wet periods as a result of the effluent distribution itself.

FEEDLOT RUNOFF

Runoff from cattle feedlots contains relatively high concentrations of several water pollutants. Tables D-1 and D-2 show some of the results which are available. Biochemical oxygen demand (BOD), nitrogen concetrations, suspended solids, and dissolved solids are some of the more important water quality variables to consider in feedlot runoff management. The forms of the nitrogen should also be considered. Biochemical oxygen demand is frequently above one gram per liter and will significantly affect the water quality of any streams it is allowed to enter. Total nitrogen concentrations frequently exceed 100 mg/l in feedlot runoff. The ultimate fate of this nitrogen must be considered because of its potential for surface water and groundwater pollution when in the nitrate form. Suspended solids frequently have a biochemical oxygen demand and adsorbed nitrogen compounds associated with them.· Suspended solids can affect the properties of soils. Concentrations in feedlot runoff frequently exceed one gram per liter. Dissolved solids in feedlot runoff can affect crop yields when effluents with high salt concentrations are distributed onto agricultural land. Dissolved solids concentrations in feedlot runoff depend on the salt in the ration; values above one gram per liter are fairly common.

Because of the large number of variables which affect the quality of feedlot runoff, large variations in values have been reported. Feed ration, temperature, anticedant moisture, feedlot surface and slope, and rainfall duration and intensity are some of the important variables which affect the water quality of feedlot runoff. Because of the large number of variables which affect feedlot runoff and the expense and difficulty of conducting experiments, only relatively simple models have been reported for predicting feedlot runoff water quality. Miner et al. (1966) and Manges et al. (1975) have reported correlations for predicting chemical oxygen demand of feedlot runoff. Miner, et al. (1966) included rainfall rate, temperature, and lot moisture in their work. Manges et al. (1975) also included antecedant moisture and temperature; however, they also included antecedant wind travel. Miner et al. (1966) also developed a model for predicting Kjeldahl nitrogen in feedlot runoff.

TABLE D-1. CATTLE FEEDLOT RUNOFF CHARACTERISTICS, mg/1 (Loehr, 1974)

Location	Total solids	Volatile solids	COD	BOD	Total N	Ammonia N	Total P	Ref.
Nebraska								
snowmelt								
mean			41,000		2,100	780	290	McCalla, et al., (1972)
range			14,100-77,000		190-6,530	6-2,020	5-920	
Rainfall								
mean			3,100		920	140	360	McCalla, et al., (1972)
range			1,300-8,200		11-8,590	2-1,240	4,520	
Texas								
dirt lot								
mean			9,500	1,460	128	56		Wells, et al., (1970)
range			2,900-28,000	1,010-2,200	9-285	2-85		
concrete lot								
mean			21,500	8,000	500	350		Wells, et al., (1970)
range			8,400-32,800	3,300-12,700	70-1,070	33-775		
Colorado		100-7,000		300-6,000				Norton & Hansen (1969)
Kansas	10,000-25,000		4,000-40,000	1,000-11,000	200-450			Loehr (1970)
Texas	3,100-28,880		1,440-16,320	1,075-3,450		4-173		Kreis, et al., (1972)

TABLE D-2. QUALITY OF RUNOFF FROM STEEP NON-PAVED CATTLE FEEDLOTS (HAMILTON STANDARD, 1973)

ANIMAL TYPE: Beef Cattle
ANIMAL WEIGHT: 800 lbs avg.
TYPE OF WASTE: Dirt-Steep Slope-Runoff
AREA: 200 ft^2/head

Parameter	lb/head/inch Runoff			PPM		
	Minimum	Average	Maximum	Minimum	Average	Maximum
Total (wet solids)	-	1196.0	-	-	-	-
Moisture	1186.0	1186.0	1190.0	982,750	990,800	990,800
Dry Solids	9.57	9.57	17.9	9,200	9,200	17,250
Volatile Solids	4.78	4.54	9.57	4,370	4,600	9,200
Suspended Solids	1.20	2.99	5.98	1,150	2,875	5,750
pH	5.1	7.6	9.4			
BOD_5	1.20	1.79	7.18	1,150	1,725	5,750
COD	3.59	4.19	35.9	3,450	4,025	23,000
Ash	2.39	5.03	8.97	2,300	4,830	8,625
Total Nitrogen	0.023	0.184	1.31	23	173	1,265
Ammonia Nitrogen	0	0.069	0.598	0	69	575
Nitrate Nitrogen	0	0.0345	0.0265	0	29	138
Total Phosphorus	0.0115	0.104	0.253	16	92	230
Total Potassium	0.0230	0.403	1.04	23	391	1,035
Magnesium	0.0805	0.115	0.138	81	109	138
Sodium	0.0805	0.276	0.805	75	265	805

During rainfall events, feedlot runoff concentrations change with time. Models which consider the dynamic behavior of water quality variables during rainfall events have also been reported (Miner et al., 1967, Kang, et al., 1970).

Models for predicting the concentrations of nitrate, organic and ammonium nitrogen, dissolved solids, and suspended solids have not been reported. Stone, et al. (1975) have investigated the changes with time which occur when manure is aged at various moisture and temperature conditions. They found that ammonium nitrogen decreased by as much as 35 percent with aging and that the mean rate of change increased with temperature and moisture content. However, they concluded that no significant changes occurred in total or protein nitrogen during the 10 to 20 day test periods and that the ammonium nitrogen was only 3 to 4 percent of the total nitrogen. Table 1 shows that ammonium nitrogen in feedlot runoff is a considerably larger percentage than this.

Under warm summer conditions higher concentrations of nitrate nitrogen have been observed, especially when relatively dry long conditions are encountered (Wells et al., 1972). Nitrate nitrogen is produced biologically under aerobic conditions.

Miner (1976) has proposed another model for predicting the water quality variables in feedlot runoff. The model is similar to that reported previously by Miner, et al. (1966); however, the new model includes additional influencing factors.

Data available for modelling feedlot runoff have been collected by a number of workers. In addition to the work cited in Tables D-1 and D-2, there are studies reported by Gilbertson et al. (1971), Miner (1967), Texas Tech University (1971), Manges et al. (1975), and Clark et al. (1975).

RETENTION BASIN

Feedlot runoff must be collected in a reservoir of retention basin because of water quality considerations. Anaerobic conditions usually prevail in these retention basins. The degree to which anaerobic microbiological transformations occur will depend upon temperature. Under winter conditions with temperatures at near 0°C, no significant biological treatment occurs; however, under warm summer conditions biological processes are important.

Some of the processes which occur in retention ponds include evaporation, anaerobic digestion, ammonia desorption, and sedimentation. Evaporation of water leads to increased concentrations of dissolved solids. Evaporation should be considered in modelling both retention basin water quality and quantity. Anerobic microbiological processes result in organic nitrogen being converted to ammonium nitrogen (mineralization) and nitrate nitrogen being converted to nitrogen gases (denitrification). Some of the organic carbon will be oxidized and provide energy for these processes. Whenever anaerobic microbiological growth occurs, new cell mass is synthesized and some nitrogen is immobilized or converted to organic nitrogen; however, in feedlot runoff retention basins the rate of mineralization should exceed the rate of immobilization. The net results of these anaerobic processes should be a reduction in biochemical oxygen demand and a reduction in total nitrogen.

The organic nitrogen which is converted to ammonium and to ammonia can be lost to the atmosphere through ammonia desorption. The equilibrium distribution of ammonia and ammonium in the aqueous phase depends upon pH. As pH increases, the fraction of ammonia increases; thus, rates of desorption of ammonia will increase as pH increases. Koelliker and Miner (1973) have investigated the desorption of ammonia under anaerobic conditions for swine lagoons. They point out that as much as 65 percent of the nitrogen added to a swine lagoon may be desorbed to the air.

Mathematical models for water quality in retention basins where cattle feedlot runoff is contained have received very little attention (Miner, 1976). Since the processes which occur in these retention basins are similar to other anaerobic processes, it should be possible to utilize many of the results of modeling related anaerobic processes in developing models for these retention basins. Some experimental data on the water quality in retention basins is available (Manges et al. 1975, Dickey and Vanderholm, 1976, Gilbertson, et al., 1971, Linderman and Ellis, 1975). Further experimental work would be desirable as additional data (especially time series data) would be useful in testing the adequacy of mathematical models which may be developed.

The pH in the retention basin is an important variable for both anaerobic digestion and ammonia desorption. The organic acids produced during anaerobic digestion tend to lower pH while ammonia losses to the atmosphere tend to increase pH. Models for pH in anaerobic digestion have been developed by Andrews and coworkers (Andrews and Graef, 1971, Andrews, 1969).

The temperature of the retention basin can be modeled using an energy balance. Retention basin temperature would be expected to be related to soil temperature and recent wet and dry bulb air temperatures. Appropriate temperature data should be collected when experimental work is carried out.

When effluents from retention basins are distributed onto land, the volatilization of ammonia should be considered. The loss of ammonia to the atmosphere will depend upon pH and the method of application. Models for ammonia volatilization during spray applications can be developed. Moisture losses during spraying may also need to be included in the model.

FIELD SURFACE

Runoff from cattle feedlots and effluent from retention basins can be distributed onto agricultural land. Runoff from field surfaces where feedlot runoff or retention basins effluents have been distributed may negatively affect stream water quality. Research on the water quality of runoff from fields where feedlot runoff or basin effluent have been applied is in its infancy. Very little experimental data is available, and further work is needed.

Some research has been completed on water quality modelling from nonpoint sources (Chiu, et al., 1973, McElroy, et al., 1976, Donigian and Crawford, 1975, and Donigian and Crawford, 1976). In many of the models, sediment is used as the indicator of other pollutants. Sediment is selected as a measure of other pollutants because it is the major constituent of contaminents from agricultural land. Since many pollutants are adsorbed to sediment, it is logical to correlate concentrations of these materials to sediment. Available data indicates that this procedure can be used successfully for nonsoluble and partially soluble pollutants; however, highly soluble pollutants may demonstrate significant deviations from simulated values (Donigian and Crawford, 1976).

Positive ions such as the ammonium ion are adsorbed to soil particles. Adsorption should be considered in modeling runoff from fields where feedlot runoff or retention basin effluent has been applied. Oxidizable organic wastes (BOD), suspended solids, microorganisms, and ammonium nitrogen may be adequately modeled using sediment loss as a measure of pollutant strength in runoff from fields where effluents have been distributed; however, further data under conditions where feedlot runoff and effluents from retention basins have been distributed onto agricultural lands are needed. Distribution of basin effluents onto land affects soil moisture and nutrient concentrations at the soil surface. Both the quantity and quality of runoff from rainfall which closely follows effluent distribution will be affected by the distribution. Soil moisture is included in the hydrological model; however, models for the transient changes in nutrient concentrations at the soil surface are not well developed. Some of the models reviewed by Davidson (1976) for transformations in the soil may be used to model the nitrogen transformations which occur on the soil surface. Since nitrate nitrogen is not strongly adsorbed to soil particles, other models may be needed for it. It may be a greater pollution hazard when it is applied to land; however, because of the anaerobic conditions present in retention basins, nitrate nitrogen should not be present in high concentrations in most retention ponds. Furthermore, highest nitrate concentrations in feedlot runoff appear to occur in the warm summer months when feedlot conditions are relatively dry, and when retention pond biological activity should be great enough for denitrification to occur.

Sediment flows are significantly affected by ground cover and soil conservation practices. The distribution of retention basin effluents onto pasture lands with good ground cover may have very little impact on stream water quality. Because of adsorption, it may be an acceptable management practice to distribute retention basin effluents onto pasture land during chronic wet periods. Further studies are needed to measure the water quality effects of runoff from field surfaces where retention basin effluent has been distributed.

Sediment transport has been modelled using the Universal Soil Loss Equation (Wischmeier and Smith, 1965), the Agricultural Chemical Transport Model (ACTMO) (Frere et al., 1975), a model developed by Negev (1967), and other models reviewed by (Donigian and Crawford, 1976 and Chiu et al., 1973).

Fan (1976) and Chiu (1976) have reviewed the available water quality models for nonpoint source runoff. Some attention has been given to the water quality of runoff where animal wastes have been applied (Manges et al., 1975); however, much less attention has been given to runoff from fields where liquid effluents from retention basins have been distributed.

MOVEMENT IN SOILS

Pollution of groundwater through application of retention basin effluent to land is of concern in some areas. The water quality of return flows from tile drained land is another concern. Nutrient and salt concentrations in soils also affect the productivity of the soil. Considerable research on the movement of nitrogen compounds, salts and other substances in soils has been reported; however, because of the complexity of some of the models and the large number of water quality variables further model evaluation is needed for some models. Hornsby (1973) has reviewed the models used to predict the movement of salts in soils.

Recently, Shaffer, Ribbins, and Huntly (1976) developed a model for water quality of irrigation return flows. This model is referred to as the United States Bureau of Reclamation (USBR) model, and it considers calcium, sodium, magnesium, bicarbonate, carbonate, chloride, and sulfate. This model can probably be extended to fields where effluents from feedlots and retention ponds are distributed; however, it would be desirable to include potassium in the extended model. The model assumes that flow is two dimensional and independent of water quality. Powers (1976) has reviewed this model and its extension to fields where retention basin effluents have been distributed.

Simulation models for nitrogen transformations and movement in soils have been reviewed by Davidson (1976). Models for simulation of nitrogen mineralization, immobilization, nitrification, and denitrification are presented and discussed. Transport models for water soluble nitrogen forms (nitrates and ammonium nitrogen) are also presented.

Mineralization (microbiological transformation of organic nitrogen to ammonium) and immobilization (microbial conversion of inorganic nitrogen to organic forms) may both occur at the same time. Available energy, estimated from organic carbon and nitrogen ratio, determines which of the processes will dominate. Hagin and Amberger (1974) have developed a model to determine if mineralization or immobilization would occur following a plant residue application. The simulation procedures of Hagin and Amberger (1974), Beck and Frissel (1973), and Browder and Volk (1977) for mineralization and immobilization can be extended to fields where effluents from feedlots and retention basins have been distributed.

A first order rate equation has been used by Mehran and Tanji (1974), Hagin and Amberger (1974), Beck and Frissel (1973), and Misra et al. (1974) to describe the nitrification of ammonia to nitrate nitrogen. Hagin and Amberger (1974) and Beck and Frissel have included pH, temperature, and soil-water content in their models.

Models for dentrification (conversion of nitrate to nitrite and volatile gases, NO, N_2, and NO_2) have been developed by Hagin and Amberger (1974), Mehran and Tanji (1974) and others (Davidson, 1976). Both first order and zero order rates have been observed; however, this is to be expected. Enzyme kinetic and microbial growth models can be used under these conditions (Aiba et al., 1973).

Mathematical models for nitrogen transport in soils are available (Warrick et al., 1971, Kirda et al., 1973, Selim et al., 1977). Adsorption-desorption characteristics of ammonium are considered using equilibrium adsorption isotherms such as the Freundlich and Langmuir equations. Both flow and diffusion are included in some of the models (Davidson, 1976). Transport of ammonium and nitrate nitrogen is considered while the organic nitrogen is assumed to be fixed in position. Mineralization, immobilization, nitrification, and dentrification are also included.

The effects on the soil when effluents from feedlot runoff retention basins are distributed onto land must be considered in developing management practices. Powers et al. (1975) has recently reviewed the effects of land application of animal wastes.

STREAM WATER QUALITY

Stream water quality models have been reviewed by Fan (1976). Hydraulic models and water quality models for biochemical oxygen demand, dissolved oxygen, and temperature are reviewed for flowing streams. Water quality models for lakes and reservoirs are also reviewed. In order to determine the water quality effects of nonpoint source runoff from land where retention basin effluents have been distributed, the runoff water quality will need to be used as an input to the stream water quality model. The emphasis in stream water quality modeling has been directed toward dissolved oxygen and biochemical oxygen demand. It may be necessary to include some of the forms of nitrogen in stream water quality models when runoff from fields with effluent distributions is examined. Some models which include nitrate and ammonium nitrogen are available (Shepherd and Finnemore, 1974 and Finnemore and Shepherd, 1974).

BUILDING WATER QUALITY MODELS FOR MANAGEMENT AND CONTROL OF FEEDLOT RUNOFF

Model development procedures for feedlot runoff water quality management and control have been reviewed by Fan (1976). The sequential mechanistic model building procedure (Box and Hill, 1967) will permit full use of available data and existing models and also allow effective utilization of new data as it becomes available.

Water quality modeling for runoff from cattle feedlots should begin with the models of Miner et al. (1966) and Manges et al. (1975) and the proposed models of Miner (1976). Models should be developed for biochemical oxygen demand, total nitrogen, ammonium nitrogen, and nitrate nitrogen, suspended solids, and dissolved solids.

Water quality models for retention basins should include evaporation, anaerobic digestion, ammonia desorption, sedimentation as well as inflow and outflow. A transient model which includes biochemical oxygen demand, nitrogen (organic, ammonium, and nitrate forms) suspended solids, and dissolved solids should be developed. Important variables such as pH and temperature should be included in the model. Complete mixing of the dissolved substances should be assumed in the initial model. Reduction in biochemical oxygen demand, mineralization and denitrification should be included in the model. A mass transfer model for ammonia desorption is also needed. Chemical equilibrium can probably be assumed between ammonia and ammonium; however, the effects of pH and temperature on the equilibrium relationship should be incorporated.

Experiments should be designed and carried out to test the model which is developed.

A model should be developed for volatilization of ammonia during land applications of effluents. Spray applications especially may contribute to ammonia desorption. A useful model can probably be developed using presently available information (Bird, et al., 1960, Koelliker and Miner, 1973).

Existing nonpoint source water quality models can be exploited in modelling runoff from fields where retention basin effluents have been applied. A sediment transport model and a model for dissolved nutrients should be coupled to the hydrological model. For example, ACTMO can be used to model sediment transport. The model for dissolved nutrients such as nitrates should include important transformation rate processes and adsorption-desorption processes. Because of variations in soil, cropping practices, and environmental variables, there is a wide range of field applications to consider. Some attention should be directed to the water quality modelling of nonpoint source runoff from land under chronic wet conditions. The water quality effects of distributing retention basin effluents onto land under these conditions need to be known. Both the quality of runoff and the ability to distribute basin effluent without having runoff are of interest. Soil cover and field conditions should be considered.

The United States Bureau of Reclamation model (USBR model) of Shaffer et al. (1976) for modelling salts in soils should be extended by including potassium and adapted to applications of retention basin effluents onto agricultural land. Nitrogen transformations and transport in soils can be modeled using models described by Davidson (1976). Appropriate experiments to evaluate and improve the proposed models are needed.

The models described above are suggested as a starting point for the model building effort required to develop the water quality models needed for feedlot runoff water quality management and control. The sequential mechanistic model building procedure described by Fan (1976) can be followed until adequate models are obtained.

After the basic model is developed the model can be extended to include runoff due to snow melt and other abnormal events which are important in some locations.

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APPENDIX E

LIST OF SYMBOLS AND CONVERSION TABLE

The following symbols are used in this paper:

ABST	absolute air temperature, in degrees Kelvin;
Bm	area of midsection of storage facility;
B1	area of bottom of storage facility;
B2	water surface area in storage facility;
C	degree-day coefficient (usually 0.05-0.06), in inches per degree-day Fahrenheit;
c'	hydraulic coefficient of soil in inches per $\text{day}^{1/2}$;
D	snow melted by rainfall, in inches of water;
E	emissivity;
EA	convective loss, in millimeters of water evaporated per day;
ES	saturation vapor pressure in millibars;
Es	stage 2 evaporation;
ESA	actual vapor pressure in millibars;
G	sensible heat flux to or from soil;
h	depth of water in storage facility, in feet;
HMAX	maximum depth of water allowable in storage facility;
IA	initial abstraction, in inches of water;
k	Blaney-Criddle consumptive use coefficient;
Ks	coefficient for soil-moisture conditions;
M	atmospheric snow melt, in inches of water;
MD	moisture deficit in inches;
N	SCS runoff curve number;
P	precipitation, in inches;
PAVLU	percentage of upper zone available moisture as a ratio;
P25	25-yr 24-hr storm in inches;
PREVAP	ratio of precipitation to lake evaporation;

PET	potential evaporation, in millimeters of water;
PONVOL	pond volume required for 100 percent control in acre-inches;
PSUNS	percentage of possible sunshine as a ratio;
Q	direct surface runoff, in inches;
r	mean daily shortwave reflectance or albedo;
RA	extra-terrestrial solar radiation on horizontal surface, in millimeters of water evaporated per day;
R_b	outgoing longwave radiation in millimeters of water evaporated per day;
RHD	relative humidity as a ratio;
Rn	heat budget at surface, in millimeters of water per day;
S	maximum potential difference between precipitation and runoff in inches;
SURF	pond surface area required for 100 percent control by evaporation in acres;
t	time after stage 1 evaporation, in days;
Ta	mean daily temperature, in degrees Fahrenheit;
Tb	base temperature, in degrees Fahrenheit;
U	upper limit of stage 2 evaporation in inches;
V	volume of water in storage facility, in acre-inches;
VOLMAX	maximum volume of water held by storage facility, in acre-inches;
W	mean wind speed at height t above ground in miles per day;
WVD	mean wind speed at 2 m above ground, in miles per day;
Z	height above ground at which wind velocity is measured in feet;
γ	psychrometric constant in Bowen ratio equation;
Δ	slope of saturation vapor pressure-temperature curve;
σ	Stefan-Boltzmann constant = 1.17×10^{-7} cal/cm^2/K°^{4}/day;
θ_a	actual available soil moisture content, in inches; and
θ_{max}	maximum available soil moisture content, in inches.

TABLE E-1. CONVERSION OF UNITS

Units stated	Units desired	Multiply by
Length		
Inches	millimeters	25.4
Inches	meters	0.0254
Feet	millimeters	304.8
Feet	meters	0.3048
Area		
Square feet	square meters	0.0929
Square feet	hectares	9.29×10^{-6}
Acres	square meters	4047.0
Acres	hectares	0.4047
Volume		
Acre-inches	cubic meters	102.8
Acre-inches	hectare-centimeter	1.028
Temperature		
Degrees fahrenheit	degrees Centigrade	(°F - 32)/1.8
Degrees fahrenheit	degrees Kelvin	[(°F-32)/1.8] + 273.15
Velocity		
Miles/day	meters/second	0.0186
Miles/hour	meters/second	0.4471